HEALTH IN THE DWELLING

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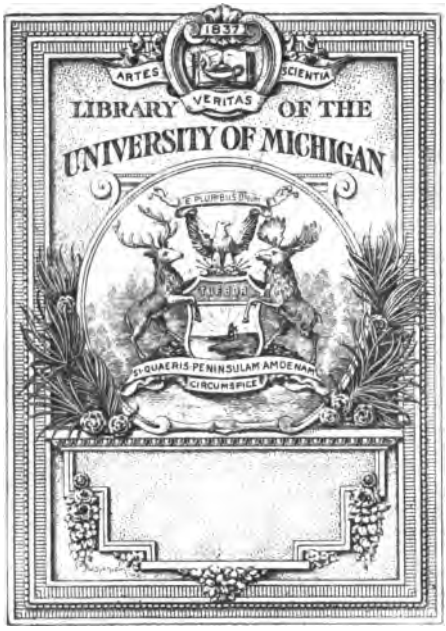
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VOLUME III.

HEALTH IN THE DWELLING.

LECTURES.

ANGLO-SAXON DWELLINGS. HEALTHY HOUSES.
HEALTHY TOWN AND COUNTRY HOUSES.
FOUL AIR IN HOUSES.
VENTILATION IN CONNECTION WITH WARMTH AND LIGHTING.
HEALTHY FURNITURE.
THE DOMESTIC USE OF GAS.
HEALTH IN THE WORKSHOP. SMOKE ABATEMENT.

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LECTURES.

ANGLO-SAXON DWELLINGS.

BY

PROFESSOR HODGETTS.

SATURDAY, AUGUST 2ND, 1884.

A LECTURE ON ANGLO-SAXON DWELLINGS.

By PROFESSOR HODGETTS.

The chair was occupied by DR. ZERFFI.

IN every civilised nation except our own there seems some kind of national pride which tends to elevate in men's minds the respect and affection which we owe to our fatherland and mother-tongue. With us, unfortunately, our patriotism is generally a cloak for ignorance. An Englishman is asked whether he speaks any given language he will say "No—English is the grandest language in the world, *ergo*, why should he learn another?" Any other man of any other nation uttering this sentiment would be stigmatized by that same Englishman as an ignorant conceited person who did not know English. And yet, what Englishman knows English? The language of his ancestors is a sealed book to him. And more than this—what does he know of the manners, dress, habits, language, modes of thought, ways of life, arts and sciences of our own race before the wretched fad set in of worshipping the "lady in the Revelation," as I have heard Rome called by those who identify her with Babylon? And now I want to tell you something about Early English Houses, and

because it is an English subject, it will be a new world to my audience. Those who are scholars of the true University stamp will turn up their English noses at English things because they have been trained to admire only Greek and Roman antiquities, which they profess to admire beyond everything else, in their trial to hang on to the skirts of Rome. Such gentlemen will know all about the Atrium, the Compluvium, the Basilica and all other buildings or parts of buildings peculiar to the Greeks and Romans, but they would be almost indignant if they were asked how those lived who crushed the power of Rome and threw off the yoke of the arch tyrant, who called Freedom from the deep and founded her Empire on the waves.

It is generally thought that we are descended from a kind of centaur—only not half horse, half man; but half horse, half alligator and whole savage! No wonder that people are shy of acknowledging their descent from such! But in the first place this reluctance to honour our "forefathers and foremothers" is impious and unchristian, and in the second place, it is contrary to history to suppose that the martial, poetic, industrious race which overthrew Rome, and bore in it the germ of the new civilization which now covers the face of the globe was a race of rough untutored savages. The remains of their arts which have descended to us, their noble language, and still nobler literature, prove them to have been men of thought, skill, refinement and enterprise. The civilization which we brought from Scandinavia was very different from that of the classical civilization of Greece and Rome. The tastes of our ancestors were totally different from those of the classic nations of antiquity, and, however excellent Greek and Roman models may have been, they clearly did not suit us. In the cold bleak North, man required warm houses and plenty of fuel, consequently Nature supplied him with enormous pine forests to build a home and brighten a hearth. Nor could better materials have been supplied for either purpose. No structure is so warm as a house of wood, and the glowing embers of a large wood fire are known

to be the best adapted to the requirements of a Northern household. In the South, where the burning sun shoots his beams during a great part of the year down on the devoted heads of poor humanity, where rain is such a boon as to induce the builder of a mansion to leave a large square opening in the roof to permit of its passage into the interior where a tank was ready to receive it. In such a climate the house was built of solid stone to keep the dweller cool—to refresh him after the sultry weather without and shield him from the heat. In such a climate the structures raised by man would naturally be fortresses to keep out the heat where it was too abundant for his comfort, and a house would mean a cool cave. But fancy an *atrium* in the Lincolnshire fens, or a *compluvium* in the Lake District during winter! *Our* Fathers, the Anglo-Saxons, were away in the summer on board their interesting war-ships, and the house was therefore more calculated to keep the owners warm than to protect them from the heat. The houses which the Early English constructed in Scandinavia were more to their taste and better suited to their requirements than any marble palaces beside the Tiber. And when they found such buildings in Britain, of the Romano-British stamp they looked upon them with contempt and pulled them down, as they cut down the owners; consequently we find that our own immediate ancestors built rather in the style of *their* forefathers than in that of the nations which they subdued. It is an absurdity to suppose for a moment that our Anglo-Saxon fathers were so struck with the beauty of the Roman mode of building that they at once resolved to adopt it; or that the dome-like huts of the British peasants would present any attraction to a race already far advanced in the onward march of civilization.

Before investigating the actual structure of the house of our ancestor we must pause for a moment to consider some of those peculiarities and idiosyncracies which rendered the English so different from the Romans, and which, apart from the consideration of climate, have so much contributed to

the production of the forms of building common in the North and imported into Britain.

The Scandinavian was in the very nature of his love and life a warrior. His gods were gods of war, his thoughts were those of a soldier. Even in peace he was a hunter, and the distinctions in his social existence were derived from warlike habits. Thus the expression *eorl* is simply significant of the military profession. It means a soldier, a fighting man. The common name for a man as a member of the community was *wer*, from *werian*, to defend to make war, and this word lives in the German *wehr* to this day. The *thane* was he who held land on condition of serving in war, the word meaning originally only servant. The *alder-man*, was the elder of the army, he whose experience and valour gave him a right to command. The respective names for man and woman were *wer-man*, or *wæpen-man*, implying the armed hero, and *web*, or wife-man, the man who weaves. The grand object of the hero's life was war, and war was conducted in a free and open way. The chosen general was the *Here-tog*, meaning the leader of the army, from *Here*, an army, and the verb *teon*, to draw, tug, the compound answering precisely to the German *Herzog*, which also means one who leads or draws out an army. This officer was chosen by the army, on account of his age and experience, not for any great superiority in valour, for where all were brave men it would be difficult, nay impossible, to make such a distinction. One of the first principles of the Anglo-Saxon military education was that the soldier in war, whether on board ship or on the field, should have no protection from any kind of fortified work. The old Viking code ordained that he should have

> "No tent on board ship, and no wall round thy house—
> Under walls lurk the coward and slave—
> Be thy buckler thy bed and thy broadsword thy trust,
> Odin's sky is the roof of the brave."

The spirit which dictated such a law would be opposed to the construction of fenced cities or towns and *a fortiori*

of fortresses. The house was the dwelling-place in peace, and had for our remote ancestors no reference to war at all. Consequently we find the Anglo-Saxon house described in such a manner as recalls to our minds the old-fashioned farm-house with its out-buildings, rather than the mansion of a later time.

I have before stated that no structure is so warm as a house of wood. Those who have been in Russia, Sweden, and Norway will bear out this statement. There wooden houses, although, generally speaking, forbidden in towns, are much affected by the peasantry. In the first place, wood is a non-conductor of heat quite as much as stone, is easy to work in and is at hand. The pine forests all over the North furnish man with the cheapest and best way of building; long trunks of the tall pine trees are laid one upon the other until a certain height is reached. The ends of the trunks are notched so that they shall lie at right angles with those in the next wall, and so the four walls are as it were dove-tailed together as a carpenter makes a square box. The log-cabin of America is similar in construction and appearance. The doors and windows are fitted into apertures actually *sawn* out of the wooden wall. The interstices between the logs are filled up with tow by an operation similar to that of caulking the deck of a ship. The interior is divided into compartments by partitions of wood. Occasionally in the case of very wealthy proprietors the chief room or *saal* is very large and lofty and used chiefly for grand meetings and social gatherings. So in the older England, whence we came, in the fifth century, to Britain, there were grand structures in wood giving our forefathers room to hold festive meetings in the winter when cold and snow prevented their great assemblies in the open-air, and frost and ice kept the dragon-ship on land. Such an apartment is the great hall of Herot in our own grand national epic of Beowulf, the description of which affords us a ready clue to the architecture of the earliest English in Britain, as the other references—to dress, arms, manners, and customs present

a vivid picture of English life in the fifth and sixth centuries:

We are introduced in this glorious poem to a palace, which consists for the most part of a large oblong building used for the meeting-place of the warriors forming the train of King Hrothgár to whom the structure belongs. The internal arrangements are simple enough. There is the oblong room or hall, with its high bank on one side supporting the throne or *heah-sætl* of the King, and below this, all round the walls, are placed the *meod sætl*, or *banks* (that is to say, benches) for the train. The walls, however, are hung with tapestry, the work of the Queen and her train of maidens. This was a necessary adornment, inasmuch as the joints between the logs, though carefully caulked and stopped up with tow, could not be hermetically sealed against the wintery blasts that cut their way through every crack and cranny. So the hangings on the walls were of immense use in keeping out the wind. Nor were the benches and settles without their bright and attractive coverings. We find, from the wills which have come down to us, frequent bequests of *sethrægl* or coverings of seats, often so valuable as to render their mention in the will quite an important item. The curious on this subject may consult the *Diplomatarium Anglicum Ævi Saxonici*, by the late eminent scholar Mr. Benjamin Thorpe, or they will find similar bequests among the wills preserved in the excellent work, by my friend Mr. Walter de Gray Birch of the British Museum, entitled 'Cartularium Saxonicum,' where the wall hangings and the seat covers are continually mentioned.

Besides the wall hangings woven by the fair hands of tender women, we meet with other ornaments of the wall wrought by harder hands and less gentle fingers. The coat of linked mail—that war-net woven by the hand of the smith,—the splendid shield with its bronze or golden boss and circling ring of the same metal, the helmet with its ornaments of warrior-pride—the wings of the sea eagle, the horns of the orochs, the grim face of the boar or wolf,—the

grand and glorious sword to which we owe this fair land, the boar spear for the hunt, the gár for combat, and the lighter spears hurled as javelins at the more distant foe, such a group of splendid weapons marked each warrior's seat, as the escutcheons and coronets in another great house mark the seats of our earls and thanes at the present day. There were but two windows, one at each end, and they were called wind-eyes; their object being ventilation rather than lighting the hall. The roof was of the gable form, rather pointed, and covered either with wooden shingles painted and gilt so as to glitter in the sun like gold, or else they were ordinary tiles highly glazed and of variegated colours.

In the centre of the hall was the fireplace or hearth, formed of burnt clay and surrounded by a low wall of fire-bricks from which the smoke rose in eddying columns to escape through the aperture in the roof left there for its passage. At each end of the long hall was a door, and during a feast both doors were open and the poorest passer-by might enter and be certain of noble alms.

To these two doors allusion was made in the early time when Christianity was young in the land and very far from being the religion of our race. A warrior of Odin, who in a grand debate in the *ting*, or open meeting of the free and brave, then convened to discuss the advisability of adopting the Christian faith—spoke as follows, "We in this life, O mighty king, are only passing guests. Man's soul is like the bird in winter which flies in from the dark cold air without, warms itself at the hearth, O king, then passes out through the other door into the unknown dark. He is gone—no man knows whence he came or whither he goeth. Now if these new doctrines will teach us whither the spirit flies and whence it comes—let us listen and become Christians."

This anecdote is related by Bede, and may be of the latter part of the eighth century, or he may have heard it, as is most likely, from others as a current story coming

down to his day from the middle of the sixth, but it is highly illustrative of the retention by our forefathers of the custom of buildings in the method brought over by their ancestors from Scandinavia.

A pretty allusion to the aperture for the smoke is met with in the "Frithioffs Saga" where the stars are said to be heavenly guests looking in and blessing the board of the heroes. So universal was the custom in Scandinavia of allowing of the escape of the smoke by a mere aperture in the roof that the common expression for spending the winter on shore was to drink beneath the sooted roof. The floor was of deal planks, but the hearth was a little cubical mound of earth surmounted by the fire-bricks, tiles, &c., to which I have referred already.

The external appearance of such a hall, judging from the description of Herot, must have been very imposing. The horizontal trunks were surmounted by the highly pointed roof gaily decked with shining shingles, or curiously coloured tiles bright and glowing in the sun. The effect was that of plates of gold used as tiles burnished and bright. At the gable ends, the ornamental boards or planks that finished off the roof were, like the ends of the Swiss cottages, and the modern Russian country houses, carved into fantastic forms. Those of the hall in question were carved into the semblance of the antlers of a mighty stag or hart, and seen from a distance it must have made the impression on the mind of the spectator of a huge stag tossing his antlered brow aloft. I may be allowed to quote a poetical description of the hall of Herot, which will convey my meaning better.

"HEROT."

"King Hrothgár sat high in Herot hall,
His Thanes sat round him.
Blades, bills and byrnies hung on the wall,
No glee wood gladdened, 'twas gloomy all,
And still as a warrior wrapped in pall,
Where the dread King Death has bound him.

Men told of that fair hall far and near,
  Both Danes and Angles.
No braver building might builder rear:
The roof trees rose straight as shaft of spear,
High o'er the hearth the blue heaven beamed clear
With its shimmering stars for spangles.

And the rising roof was full richly wrought
  And fairly furnished
With gilded gables, and gold work brought
From distant lands and dearly bought,
That by many a golden thatch 'twas thought
All blazing and brightly burnished.

At either end by the eaves on high,
  Each other crossing,
Huge horn-like carvings met the eye,
That glittered and gleamed in the glowing sky;
Afar men thought a huge hart to spy,
It's beam'd brow to the breezes tossing.

And Gleemen and Guthmen this high hall,
  This dearworth dwelling,
The hall of the hart were wont to call;
And the thriving thane and the thriftless thrall,
Would wonder and gaze at the warfast wall
Of wealth hoards in wardage telling.

On the walls within the rich wrought web hung,
  In set shape showing
The deathless deeds that the skalds have sung:
How thundering Thor his huge hammer flung,
That hard on the Frost Giants helmets rung,
Setting their black blood flowing."

The word Herot means a stag, and is the old form of our word hart, and its position at Hartlepool which derives its name from events in the story, has already been pointed out.

When the winter set in and the meetings in the open air were impossible and the viking expeditions equally so, such a grand Hall must have been a bright scene indeed. The roaring fire in the centre; the splendid colours of the gorgeous tapestry, shown up by crescents or iron lamps hanging from the rafters; the four massy pines supporting the roof in the centre of the hall, in the stems of which

some rude likenesses of Thor and Odin, Frigga and Freya, carved, painted and richly adorned with gold and gems; the brilliant arms glittering from the rich coloured ground of the tapestry, the gay dresses of the seated warriors, red, blue and white, richly bordered with beautiful gold fringe. the harpers with their harps and gay mantles occupied the centres of the hall formed a bright and noble scene. On each side of the fire and around the blaze the busy cooks plied their art. Behind the seats of the joyous warriors golden-haired damsels passed with such jugs as we may see, this very day, at the British Museum, into such horns as that rescued from the tumulus at Taplow, and also forming part of the National treasure in Bloomsbury.

When the lady of the house, followed by her maidens and the other ladies who were present at the feast withdrew (as is the custom amongst their descendants to this very day), they sought the bower or women's apartments, built off from the great hall, and entered by means of a door at the side of the high seat or dais. In these rooms the maidens of the household spun flax for the linen of which the fine underclothing was made, or wove the web and worked the threads in the wool for the tapestry hangings of the hall and other rooms. Then there was the "*máthum* house," or treasure chambers, where rings and bracelets and money were stored. Then came the "*wæpen-hus*," or armoury, with its store of helmets, byrnies (or coats of mail), white shields for the inferior warriors, spears of all kinds, bows and arrows, sword and seaxes. Again, beyond these places were the out-houses for the *ceorls*, or free labourers, and the thralls or slaves. Then came the *cycene*, where certain preparations were made, and some portion of the cooking performed, that done in hall being confined to the roasting on the spit, and to the boiling of the grand stew or soup in the gigantic cauldron swinging over the royal blaze in mid hall. All these buildings were to the rear of the great hall, and they were none of them higher than the ground floor. Of these buildings in the rear special notice is taken of the *bæc-hus*, where the

various kinds of bread alluded to in a former lecture, were made. The *breæw-hus* was a most important element in the comfort of an English household, if all tales be true, scarcely inferior in importance was the *mealt-hus*, or malt-house, where the malt was stored that should yield the warriors the "liquor that they loved." Then came the *mete cleofa* or pantry, a building set apart for the preservation of the food of the household. And when we consider what the household was for which provision had to be made, and the scale upon which those champions were fed, we may imagine that this mete cleofa was hardly inferior in size as well as importance to the grand hall itself.

One of the most exhaustive writers on this interesting topic is the eminent German Saxonist, Moritz Heyne, and he suggests that one of the group of out-houses constituting the Early English Hall, to which the term spíc-house was applied, must have been devoted to the curing of various smoked meats, rather than the storing of them, and I am inclined to agree with him. To such of my auditors, who are familiar with German, I recommend the perusal of the excellent little work by Moritz Heyne, 'Ueber die Lage und construction der Halle Heorot,' published at Paderborn in 1864.

Vegetables were preserved in the so-called *hed-ærn*, and the wine was kept in a cellar dug under the earth and called the *win-ærn*. The word *ærn* simply means *a place* and not necessarily a cellar, and I must be understood as calling it a cellar on the hypothesis of Heyne. But it may have been only another out-house kept cool, as peasants in Russia have a cool place for keeping food in the summer. As these places in Russia are cellars, however, and the whole construction of the Russian house agrees in so many particulars with what we read of the Early English houses, there is nothing absolutely against the cellar theory—save the negative evidence of not meeting any definite notice of the cellar as such, in the MSS. The word *ærn* as a suffix means simply a place, thus when used adjectively we get northern, southern, western, and eastern, implying of or

belonging to the *place* of the point of the compass alluded to. The *hors-aern* was therefore the stables where the "keenest whirlwinds" were confined.

For such corn as was consumed in the house there was the *quaern* (Swedish, *kvarn*) or hand-mill. But besides this there was the *mylen* or wind-mill that ground in larger quantities. The cows were confined in the *scyppen* or cow-houses, and cart-houses in Germany are called *schippen* to this day. Then came the *waesc-aern*, or wash-house, where the linen of the household was washed, and considering the scrupulous cleanliness of our forefathers this must have been no mean portion of the establishment, for they used table-cloths, towels and napkins, which, besides the linen portion of their clothing, had to be kept white and clean. Such of you as have travelled in Sweden or in Russia must have been struck by the number of bathing houses for all classes of the people. Hot baths, vapour baths, and cold baths can all be had at prices varying from a penny to six or seven shillings of our money, and the Russians especially are most particular in visiting the bath-house generally once a week, but certainly never less than once a fortnight. They say that they require in such baths sufficient heat to keep them going for another fortnight. Thus when Tacitus speaks of the constant use of the warm bath by northern nations we know what he means, and we are led to understand why our forefathers paid so much attention to the bath as to have a separate building provided for it in their large houses, just as the Swedes and Russians do at this very day.

Now all these places which I have mentioned to you are [illegible] connected with the great Hall of an Anglo-Saxon [illegible] person of distinction, and you will very likely [illegible] they are houses not a house. And I reply that [illegible] original meaning of house was home, rather than only [illegible] just as in a grand farm in some dear old out-[illegible] where the word "Threadneedle Street" has [illegible] such a place were within the province

of Imagination), we might find a lovely old English farm-house with no steam ploughs, and called Wardle's Farm, Dingley Dell; there we should find the house itself not more than one story high, and all the various departments of the household except the kitchen carried on in out-houses, as is the case in Russia. The true English style of building is confined to one floor and that is the ground floor. By this means the fatigue of going up and down stairs is avoided, and the possibility offered of having all the dwelling rooms of the same temperature, and of passing from one to another without running the risk of chilling the whole body in the transit.

In the Scandinavian houses of an early period there does not appear any trace of the unwholesome staircase which embitters the lives of so many people in this country. Certainly they had stairs, but they were the steps by which to mount the watch-tower, built on a hill near the house and used by the watchman to scan the whole neighbourhood, to see whether there were signs of intruders or visitors. The warden who thus kept watch would report to the lord of the manor any strange sail approaching if the house were on the coast. The Romans, although building very much on the system of each room opening into some other, had yet the custom of building castles and castellated mansions, and from the Romanized Frank the Normans obtained the idea of building towers as dwelling-places. From them the English, in the time of the stupid "Confessor," gained the idea. But it is not English, and whatever we may say about the system of building room above room, instead of building them all in one flat, we don't like it at heart and have only to try the northern plan to find how much better it falls in with our wants than the tower system of the Romanized Scandinavians, whom we call Normans, but who were really unprincipled renegades from the faith, habits, and speech of the glorious old North from which both Normans and English originally sprang. But even in the eleventh century the representations of towers are very strange, as though still unfamiliar to the English mind.

The poorer classes, of course, lived in less pretentious dwellings, and, like the huts of the Russian peasants, their houses consisted of only one room, sometimes partitioned off into smaller apartments. But I am not by any means prepared to say that they were anything like so badly off as the poor are in this great Metropolis. They were dependent on the rich landowners, it is true, but their dependence was not a dependence of disgrace, it was simply connected with the military service which they could render, and this bound all classes together in a grand family, united in the common national cause. As long as they did their duty, both civil and military, their lords were not unmindful of their wants. They were allowed wood enough for fuel and to spare, while the timber for their huts was supplied by the lord of the manor.

In the houses of less pretension than the grand Hall of Herot where we have noticed outhouses of various kinds adapted to various purposes, we discover that the chief feature of the building, the hall itself, was omitted, and the space which it would have occupied was divided into compartments by *scide-wealls*, or partitions. These partitions are supposed—but, I think, on very insufficient authority—to have been constructed of wicker-work filled up with clay. The evidence is more in favour of such divisions as sailors call "bulk-heads," made of planks of wood. A house would thus be divided into four or more compartments, of which the chief would be the general dining-room, another the women's apartment, another the place for certain domestic animals, and fourthly the place which we might call the scullery or kitchen, all of which were distinctly separate from the more stately "Hall."

Moritz Heyne, in his little work on the Hall of Herot just mentioned, cleverly refers to many modern structures in the Germany of to-day, in illustration of his sound deduction that the various rooms in an early English house were buildings not only on the same floor, but even detached from each other and built in the same yard.

It is unnecessary to say that our forefathers were

acquainted with stairs. They were cut in rocks, and when towers were built, they were involved in the construction ; the qualified assertion made above (at p. 15) applies only to their employment in dwelling-houses, which was introduced some time after the settlement in Britain. The Teutonic hatred of town life, and of the confined feeling of being enclosed by walls, was more emphatically exhibited by the Scandinavians than any other Teutons. And the English, on coming to Britain, had absolutely no reason to copy either British or Roman models. They had come by invitation of a weaker race to aid them against certain enemies. Those enemies they defeated by their own strength and knowledge of the art of war. That they despised the Britons is a matter of course ; for they worshipped physical strength. They were moral in their lives, stern in their manners, unyielding and obstinate in their convictions, and thoroughly satisfied with themselves. To these fundamental principles the Britons offered a striking contrast. They were not physically strong, they were far from leading moral lives, their manners were more lively and engaging than those of the English ; and we may see among the descendants of the Kelt at the present day a much greater brightness of style and desire to please than obtains among the descendants of Odin. The Scandinavian Englishman had been taught to despise the shelter of walls in war. Nay, the Berserkir, a class of warriors specially trained to seize the shields of the foe in their teeth, attacking the enemy with bare hands, had the habit of flinging their own shields away after the first discharge of arrows and javelins had been received upon them. Their laws and customs were all dead against walled towns and castles. Why, then, should they adopt them from a race which, despite their aid, had failed to defend itself from another race of inferior advantages and resources, over which the English gained easy victories? Accordingly, we find among the English remains preserved in the British Museum no traces of any copying from Roman or British models. Even when Britons had houses of brick, when Roman villas were still standing

in Britain, and were occupied by Romanized Britons, the Englishman built his log-cabin or cluster of cabins forming a house ; and these homesteads were constructed in the rambling, disconnected manner best adapted to avoid the danger of fire, or rather to prevent the spread of fire, the one element which the Teutons dreaded. Nor should we feel surprise at the greater number of remains of Roman pottery than of English, when we consider that for the decoration of the house no such articles were (as a general rule at least) employed by Englishmen.

Although the word potter is evidently a recent addition to the vocabulary, the *cylene* or kiln, as a place for drying, occurs, and the workman whom we should call potter, is designated *croc-wirhta*, crockery-wright or crock-worker; while the brickmaker or tile-maker is called *tigel-wyrhta*, translated by Bosworth by "a tile or pot worker, potter." The word is from *tigian* or *tigan*, to draw, and the substantive *tigel* stands in the same relation to the verb as the German *ziegel* (a tile) stands to the word *ziehen* (to draw). In fact, the substantive does not indicate merely a tile, but anything that can be made by the potter and *drawn out* of clay. In Bosworth's Dictionary a remark is made that "porringers are to this day called *tigs* by the working potters." The adjective form is *tigelen*, *quasi* tilen. The tiles used for a roof are called *thæctigel*, *i.e.* thatch tiles; thatch being cognate with the German *dach*, a roof, or *decke*, a cover. The final *c* in English becomes *tch* in many words, and generally after a *soft vowel* (i, e, æ, or œ), as *wicce*, in modern English becomes "witch."

As the earliest houses of the Anglo-Saxons were of wood, and the baked clay portions of the edifices were confined to earthen floors, and hearths, so when stone became used there was at first, very naturally, a tendency to imitate rather the style to which the builders had been accustomed, than to work upon Roman or other models. Accordingly we find the same simple arch that we meet with at the present day in Russia, in the Anglo-Saxon churches.

Singularly alive to the demands of an active faith,

the Christian Anglo-Saxon was remarkable for the extreme simplicity of his own dwelling, and the disproportionate gorgeousness of his temple, a feeling which manifested itself in the tribute to the gods of the gift of enormous strength expended in their service by rolling huge blocks of granite by main force to form such a structure as Stonehenge, while the meanest hut served the warrior for a dwelling or a hall, like a big booth at a fair was regarded as the grandest possible form of dwelling even for a king.

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century, the palm of usefulness is decidedly borne by the smith, while the shoemaker takes the second place. In these *Colloquies*, though the carpenter or wood-wright is mentioned with praise, he has to yield to the smith in point of importance; while the potter is not mentioned at all, his art being evidently of too little value in the eyes of the interlocutors to be worthy of any special mention. And it is remarkable that the wood-wright alone claims the credit for building houses and ships; this claim is disputed by the smith, who tells him that without tools made by him (the iron-smith) he (the wood-smith) could do nothing.

A very curious circumstance respecting Saxon architecture is that the head of a column retained in stone the pattern of its wooden predecessor. The wooden column had been cut into a long, cylindrical form, having for a capital a mere butt-end or block, such as may be produced by shaving down a piece of ordinary fire-wood, leaving a cubical portion untouched at one end. Such is the simple construction of the original Saxon column, and such a form is reproduced in stone. Sometimes this simple block was carved into a rude representation of foliage, but most generally it was left plain, and without any ornament than its own club-like strength supporting the superincumbent arch.

Thus Christianity (although at first received with extreme caution by the English, who always protested against certain dogmas of Rome from the very beginning of their reception of the faith) had struck firm root in good ground, and its growth was rapid, yet healthy. The strong minds, that would use their own judgment in deciding so important a matter as the national faith, pruned that faith of certain accessories which they saw at once were excrescences; but succeeding generations, coming into closer connection with Rome, were led by their habit of submission to the dicta thence promulgated to accept them as gospel, until a future age—now not long behind us—threw off the shackles, and left the English Church pretty much as it was in the time of Ælfric.*

* This prelate held the see of Canterbury from A.D. 995–1005.

But the first churches were certainly not the work of the *tigel-wihrta*, save, perhaps, that the tub-like or jar-like column may have been a copy of the outer form of the English jar, although it is just as likely to have been caused in the first instance by the chipping or shaving away of the portions of a wooden column or trunk lying between the centre and the two ends, leaving the centre of the same diameter as the original trunk, and squaring the two extremities into cubes, forming respectively the base and the capital of the column. Such a process would leave the Saxon column as we find it in many parts of England, and such a process was doubtless the *modus operandi* of the wood-wright who built the edifice. Later on, the shafts were straight, as there was no reason why they should not be when there was stone to work in and no bulging centre to cut away. But even in the later times, in times after the Conquest, when the straight shaft was the rule of building, there was no attempt at Greek or Roman capitals. Even when the foliated capital occurs, there is no doubt of its being derived from the purely Scandinavian source referred to already.

When motives of economy did not demand that the materials of the roof should be of humble straw or shingles, then the *tiglere*, or tiler, came boldly forward, and the ridges of the arches were his work, the delicate corrugations of the cupolas were made by him, and more recently, the bricks of which the various ornamental portions about the windows were constructed, came from his hand. The stone *timberer* (which sounds rather as from a neighbouring island than sober Saxon diction) raised the pile; the *tiglere* formed the roof and many ornaments. Then the earthen vessels in which precious wine was stored were also his manufacture.

Before the introduction of glass for windows, they were, of course, as narrow as possible, being mere slits for the passage of air (wind eyes, or eyelet holes for wind); but towards the end of the seventh century, Benedict, Bishop of Wearmouth, and Bishop Wilfrith introduced glass for

church windows, and it was applied to ecclesiastical purposes before it was used in private buildings.

The well-known crypt in the Church of St. Peter's, at Oxford, is one of the oldest now remaining in England. Dr. Ingram, the celebrated Saxonist, and editor of an edition of the *Anglo-Saxon Chronicle*, attributes it to the time of Alfred; but it is evidently of much later date, although undoubtedly Anglo-Saxon. The capitals have the butt-head appearance which I have noticed, but they contain elaborate sculpture of a foliated pattern, and the shafts of the columns are straight. The late Mr. Thomas Wright, the well-known antiquary, has given some fair illustrations of the *jar* column, to which he applies the term baluster. I have no doubt that the respective age of the two forms will be ably investigated by others better qualified than I am to undertake the task; but I throw out these remarks as the result of observations in various parts of the world.

The word timber is pure English, free from all Roman or Greek taint, and we know that the word means *wood*. Now, the Anglo-Saxon verb to build is *timbrian*, and we have used it in speaking of ships until quite lately in the expression, "a well-timbered craft," simply meaning well built. Now, suppose this expression carried over (like the word *linden* to Beowulf's iron shield) to the iron walls of New England, and you have before you precisely what was done when house builders abandoned wood as the only material for building, and began to work in stone. Their constructions were called *stán-ge-timbru*, stone timberings or stone buildings; and it is not likely that they should suddenly have dropped all their old associations with their work when they could not even do away with so suggestive a name. It remains in German to this day as the name of a room—*Zimmer;* a carpenter being a *Zimmermann* in that language, not implying that he keeps to his room, but he is a builder; a house, too, in German may be said to be *gut gezimmert*—well built. *Frauenzimmer* is a being of female build. With the name, much

of the art went over to the stone, and we find constant repetitions in the mineral of what must have existed in the wooden material. Delicate ribbed-work, executed by the *tigel wirht* of tiles, and of a semi-cylindrical form, bright with many colours (similar to those spoken of by Tacitus as peculiar to the Northern Germans, and as possessing a beauty of colour and brilliancy that no Roman tiles possessed), form arched roofs such as might be supposed to be produced by the boughs of shady trees bent into the form of a cupola or dome. The arch itself is such as we see in long vistas of bending boughs viewed in perspective, and forming in their average effect a semi-circular arch. And the early column of support was the roof-tree, the mighty shaft spoken of already in Beowulf, and known in far back ages in Scandinavia as bearing in the swelling centre the carved semblance of the household god. Sometimes there were two such columns, and then Thor and Odin were the supports of the roof, as they were of the faith of our sturdy forefathers. They were, in more senses than one, the *roof-trees* of the house and race. The roof-tree has passed away from among the things that are, but the expression remains a cherished one to this very day, retaining a sacred halo floating round it that even the superior glories of our Christian day cannot quite efface.

The early English have been sneered at for not having adopted a higher stage of civilization than their own. But the question is not by any means settled whether Roman civilization was higher than our own. To me it seems that had the Roman culture been really superior to ours, on the principle of the survival of the fittest, ours would have gone down before it. The *inferior* Teutonic civilization would never have so completely crushed out the *superior* Roman. Instead of being Englishmen at the present day we should have been a sort of caricature of the debased Roman school. For the Romanism that met us in Britain was already debased and offered no attractions, no inducements to our sires to become copyists. When the descendants of the grand old

race have stooped to the mimicry of another they have always had cause to repent it. Before their conversion to Christianity they never copied other nations at all, and even when they were converted to the Christian faith, they were very careful in assuming anything foreign and rejecting what was English. What is very curious, too, is that as soon as they began to imitate they fell before the race they aped. Upwards of eight centuries' interval has not been sufficient to wash out the Norman stain on our manners, customs, and language, consequent upon the silly affectation of Normanisms practised at the time of the Confessor. Nothing is more contemptible than the imitation of one man by another, but the imitation of a race by a race intensifies the meanness in the ratio of one to a nation. Had we endeavoured to improve our own instead, the case would have been different indeed.

In a lecture which I had the honour to deliver at the British Museum on the Anglo-Saxon Antiquities there preserved, I took occasion to point out how very different those remains were to those of the Roman stamp. We can see in the national collection how much at variance the forms are, and on that occasion I pointed out the general characteristics of certain curves in the jars and jugs there preserved as being harmonious with parallel forms in the architecture. It is true that the curves noticeable in the English jug are not so pleasing to the eye of the trained art critic, but they possess a greater charm for me than mere external grace in proving that our English ancestors were too proud to copy Rome. The very same curves noticeable in those ugly jugs are to be found in the columns supporting the Saxon arch! I have before told you that we are able to trace the influence of the early Scandinavians observable in modern Russia, where they have remained unchanged since the time of Ruric. And you may feel surprise when I tell you that this peculiar Saxon arch with the curious tub-like or jug-like column is to be found in the older Russian churches *passim*. Not that there are any very ancient churches there. I have seen nothing older than the end of the

fourteenth century, but still the type there preserved by the conservative hand of architecture (who is own sister to Folk lore and legend) has been handed down to the modern Russian as it has to us, and from the selfsame source. The Saxon arch with the bulging column is to be found all over Moscow. Nor is this all, the double arch with the centre shaft omitted is found there, as it is in our own Saxon churches. It is rarely found in Scandinavia now, but it does occur, and when it is found it presents the same arch, the same column, the same zigzag pattern that we are familiar with in England on the one hand and in Russia on the other. This is a fair proof, among countless others, of the expansion of Scandinavian civilization East and West. In Britain it drove out the Roman forms, and stamped out whatever might have remained of an indigenous nature on the island.

The Scandinavians possessed a peculiar veneration for everything circular. This was derived from the ring form of the Horizon, the hemispherical vault of heaven, and the teachings therewith connected. I had the privilege and honour of calling the attention of the English Public to certain considerations connected with the ring at a Lecture delivered in the Anglo-Saxon Room in the British Museum at Christmas. And those mystic considerations then enunciated, I believe for the first time before an English audience, led our forefathers to the choice of the circular arch. The Ting stones were set up in a circle, as we may see on Salisbury Plain at this very day. The shield was emphatically circular, and in fact every object capable of bearing the circular form was made from mythological reasons to assume it. The zigzag pattern, as typically English as the circle, is the result of the so called frætwork for which our ancestors were famous, even after the Norman block to our progress. The word comes from the verb *fretan*, to gnaw or to devour, and lives on in the German *fressen*, and our own "to fret" or devour our own peace of mind. The application of the word to the ornament is referable either to the saw or tooth-like appearance, or to

the fact of the original model being cut into such saw-like forms as appear in the arches. It subsequently became applied to any kind of ornament that was elaborately worked, and the English goldsmiths at the time of Ælfred were celebrated for elaborate productions called fret-work.

We have seen that the earliest dwellings of our race were timber huts, built in the Northern style prevailing in the North to-day. When it became necessary to guard against the attacks of such enemies as Picts and Scots and Britons all combined, stone foundations were used to strengthen the building. When Christianity was received, and the stone temples, formerly raised to the gods on account of the indestructibility of the material, were done away with (or rather disused, for they remain in parts of England to this day)—when, I say, these rough stone temples fell into disuse then temples to the God of the Christians were constructed. As the learned writer on this subject, Sharon-Turner, informs us, the first churches were of wood, and like the hall of the noble unprovided with glass for the windows. The columns supporting the roof increased in number, and as the churches increased in size the number of columns increased. And as the pine gave way to the oak and elm an aisle produced by the use of such thick branching trees would soon reproduce the arcades of the forest whence they came. And, later on, when such building emulated the productions of the forest in stone, we have stone columns with foliated capitals of a peculiar form, evidently suggested by the boughs of trees. The round Saxon arch is strikingly arboreal, nor is the whole effect that of debased Roman, but of another copy, from another point of view of the glorious models presented by the forest and the grove in which worship had formerly been performed.

So of the houses. The tiler supplied his red and coloured tiles. Bricks and stones supplied the place of timber, but the builder remained the *timberer* all the same, although his material had changed. A second story, often of wood, was added to the English stone house in the Norman times and the cheery old homestead gave place to the donjon,

like castellated building of stone with its shuddering staircase and some unwarmable rooms. The wrong done to the race by these Norman ravagers has not yet been effaced, and in the discomfort in the jargon of Norman French, and still more barbarous mediæval Latin, we may see the folly into which Englishmen may run when they try to imitate foreign models. The chief features of the English house are—large, ample rooms, easy of access, and open like the English heart to all who seek reception or who claim its shelter. Free—open—grand old halls, simple and yet tasteful in arrangement, side buildings on the same level for the performance of various household duties—a drawing-room for ladies :—The Norman gives us dark-browed beetling towers of defence, built high in air to watch for enemies that lurked in every bush, comfortless little rooms with many little openings to the air through which to watch and shoot the approaching stranger, whether friend or foe! And for the women of the household prisons and stout bars. The Norman slang is dead amongst us. We are beginning to find out that our own tongue is best, and certainly when English hearts shall feel the thrill of joy that real pure English rouses, then the craving will be felt for English architecture, and we shall be again, what we should have remained, English to the core.

The CHAIRMAN said he was sure all present would agree that they had listened to a most excellent lecture, full of the deepest patriotism, of admiration for the Anglo-Saxons, and of that spirit which would never die out in England. At the same time he hoped there would be no effort to re-introduce the Saxon mode of construction, nor many of the Saxon customs. Everything in the development of humanity had its appointed time, and in its own time nothing was grander than what was done by the Anglo-Saxons. Everything showed that they were in the end the conquerors of the Romans, and eventually smashed that civilization which was to a certain degree civilization, only it was not the right one. At the time when it came

in contact with the Saxons it was already declining; it was a kind of civilization which thought that mere outward formalities, were the things which really made a great Roman, or a modern Englishman; but that was not civilization. The heart of Rome was corrupted, whilst the heart of the Saxon was in its right place; and whenever that was brought out, and the more it was brought out, the better it would be. He could not quite agree in all Mr. Hodgett's etymology; *erl* was an honest man; and *hertzog* was nothing but a translation from the Latin, from *dux*, *duce*, to lead; and *hertzog* was one who had to lead an army. He would conclude by proposing a hearty vote of thanks to Professor Hodgetts.

PROFESSOR HODGETTS in reply said he must be allowed to say that he had not uttered one single word of theory. *Erl* or *jarl* only meant war; it had nothing to do with *Ehre*, or *Ar* (*honour*) in Beowulf, and in all Anglo-Saxon glossaries it was translated "one who fights," and in the Scandinavian world *jarl* always meant a leader in war. There was no doubt the old Anglo-Saxon was cognate with German, but it was not derived from it; *hertzog* came from *ziehen*, *zog gezogen*, to lead; it had the same meaning as *dux*, but was never borrowed from the Romans. His derivations would be found in Ælfric, Sharon-Turner, Palgrave, Thomas Wright, and Thorpe, to whose works he would refer. Many Saxon words were similar to German, but were not derived from it; being all Aryan in origin, there was of course a near relationship. Any one who was interested in the subject and would call at his house, would be welcome to inspect his library, which was the most complete in Anglo-Saxon literature in the kingdom.

Mr. WILLIAM WHITE in proposing a vote of thanks to the Chairman said there was little doubt that the character of Anglo-Saxon architecture was derived from the character of the soil, a similar mode of construction in timber being found prevalent in Sweden, even to the present day.

HEALTHY HOUSES.

BY

T. PRIDGIN TEALE, M.A., F.R.C.S.

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A LECTURE ON HEALTHY HOUSES.

By T. PRIDGIN TEALE, M.A., F.R.C.S.

THE chair was taken by F. S. Powell, Esq., who said he deeply regretted that Capt. Douglas Galton was prevented by ill-health from occupying the chair. It, therefore, devolved upon him to introduce Mr. Teale, of Leeds, a gentleman who occupied the first rank in his profession, whose industry had not been confined to his professional duties strictly so called, but who had given great attention to the applications of science to the domestic arrangements of the house, and who stood in the very front rank as a practical sanitarian.

LECTURE.

There are over 24,000 medical men in the United Kingdom whose lives, abilities, and energies, are devoted to the preservation of health, and the cure of disease; and yet until the last few years there was hardly a house in the kingdom that was not at times a source of illness, and there were very few householders who knew or cared to know whether their houses were not manufactories of disease, providing in "preventible sickness" a very large portion of the occupation of these 24,000 medical men.

When, six years ago, in a lecture before the Leeds Philosophical and Literary Society, I ventured to state my conviction, that "probably one-third of the incidental illness of the kingdom resulted from causes that were preventible," and that "very few houses were safe to live in," I was

looked upon as an enthusiast, who took an exaggerated view of the insanitary condition of the kingdom.

Now, such statements would almost be pronounced to be truisms, so great progress has been made in the diffusion of sanitary knowledge, and in the discovery and rectification of sanitary defects. Of this progress good proofs are afforded by the fact that it has been possible to hold this International Exhibition devoted to matters affecting health, and by the statements made by Sir James Paget on Tuesday last as to the diminution of preventible death and illness during the last ten years. And this progress, let it be remarked, has taken place without recent sanitary legislation, as a result of the diffusion of knowledge of sanitary matters, of an increasing and more intelligent appreciation of such matters by the public, and of an awakening to their responsibilities by those who have the power of setting things right.

Much indeed remains to be done, much can be done by using more fully (shall I say more loyally and unselfishly?) the sanitary laws we possess. More will be done in due time, by increased powers granted by the legislature, but granted, I trust, after most mature study, and with as little interference as possible with personal and local freedom.

The basis of all true sanitary progress must be the spread of the knowledge of sanitary principles among the people. The spread of such knowledge is the great aim of this International Exhibition, and is the object of the lecture which I have the honour of giving to-day.

I have said that our houses are but too frequently very hotbeds of disease. Every old house in the kingdom needs that its sanitary arrangements should be reviewed and revised on the principles established within recent years. Every new house ought to be made as far as its construction goes, perfectly healthy. And houses will be made perfectly healthy, if those who have to live in them, and those responsible for their construction will but learn the easily learnt and very simple laws of correct construction. Sanitary science is no mystery. Sound sanitary arrange-

ments need not be, ought not to be, costly. The principles which have been arrived at are fortunately so clear, and can be expressed in such a simple form of construction, that to carry them out aright should be far less costly than to carry them out in a faulty and vicious manner. Things that are complicated, are liable to go out of order, and their very complications are often a departure from, or a violation of, the principle that should underlie their construction.

My duty to-day shall be to lay down some of those simple principles, which you may easily understand, and apply in practice in your own houses, or by knowing them secure that those responsible for the work shall do it in a proper manner.

[Mr. Teale then proceeded to explain and demonstrate from a series of diagrams on the walls of the lecture room.]

I well remember, when a little boy, going into the cellar kitchen of my father's house to see the men take up the floor, because the basement was overrun by rats, and seeing them expose nests of rats under the floor, and a foul piece of drain under the flags from which they ladled out bucketfuls of filth. All this came from the scullery sink, which was some distance away from the front of the house, and the waste from the sink was taken from this old-fashioned brick drain which allowed the liquid portions to ooze away leaving horrid filth behind. Perhaps the simplest and most universal portion of our sanitary arrangements is the sink. There is hardly a cottage that has not a sink, and, therefore, if we understand what a sink has been and what it ought to be we grasp a fundamental principle for our sanitary constructions. The sink is intended to take away all foul slop water from the house. What used we to do with the sink? Almost invariably we carried it under the floor into the drain; we detained a greater part of the filth inside the house and beneath it. That is a most absurd idea, and an evident violation of everything that is right, to put filth under a house. But this was done until late years, almost universally. We sometimes had a drain only, but some-

times we had done much worse, and even put a cesspool under a house. A medical man in Harley Street told me a few years ago that he actually found five cesspools under the basement of his house. That is what used to be done, and it is very simple to say that it ought not to be done. But what ought to be done? We want a sink to carry the contents away, and for that purpose we place the sink as near the outer wall as we can in order to carry a pipe through the wall into the outer air, and let this pipe open into an open gully, and that no foul air may be drawn back into the house we put a trap there. In these two diagrams showing what is wrong and what is right, you have the basis of the sanitary arrangements of a house. You must take all waste matter as quickly out of the house as you can, and when it is out of the house disconnect it from the drain. To show you how you may still be wrong, though you have the sink near the outside wall, and take the pipe outside, I have put up a diagram of what is commonly done; you have the sink or a pipe taken outside the house direct into a drain and have no trap whatever upon it; nothing to check the gas coming straight into the house. That is common enough in many of the cottage kitchens and cellars of our large towns. The remedy is simple. Put a trap underneath the sink and carry the pipe into an open gully to cut off the inlet from the sewer. This is called disconnection. Every waste pipe from a sink, from a bath, and from a lavatory in a bedroom must not be only trapped but go into the open air either above or below the grating, otherwise you are connected with the drains and are unsafe.

There is another department of the house which is a very serious danger, and that is the closet. That is to be dealt with in the same sort of way. Formerly, in many houses, the soil-pipe of the closet went direct into the drain, and when that is done there is nothing to prevent the gas coming back into the house from the drain. Houses were also supplied with almost the greatest abomination ever invented, what is called a pan-closet. Whoever has

one in their house ought to have it taken out at once; it is a source of immense danger, and if people could only see one broken into, they would be perfectly horrified to think that they had such a thing in their house. The machinery of the pan-closet is so contrived that in order to work it there is a hole into the worst part of this horrid affair allowing the gas to come back into the house. No architect who respects his reputation, no builder who has any regard for his future credit, would ever think of putting such an appliance into a house. He would put what I have called here the modern substitute. There are in this Exhibition some very beautiful contrivances, and, as far as I have looked around, I do not see a single instance of the old pan-closet, and I hope it is dead and gone. I have represented here the simplest form of construction that we want, and you must secure the principles of this simplicity if you want to be right. If you deviate from that do not sacrifice the principle, that the container shall be simply a trough for holding fouled water as short a time as possible, which shall be flushed out in one way or other. There are certain alternative arrangements which are valuable in certain positions which I will not go into now, which are called valve-closets. Then you must have the shortest cut to the outside of the house, and you must have the pipe outside; then if it should leak outside there is no very great harm done. Another point is that the pipe, into which your primary pipe discharges, shall be kept as free from sewer gas as possible, and that is done in this manner. It is carried up above the roof to open at the top, and it is carried down below just beneath the flags into an open trap where the air can get at it. It simply goes into a tube open at the top and bottom. Whatever your arrangements are let them secure those principles and you are not far from right. To sum up the points I have indicated, the sink, the bath, lavatories, and closets should all discharge as quickly as they can outside the house into structures which do not communicate directly with the drains.

In order to let you know what we used to do, I will go through the points of a house drawn here which is made to represent every possible mal-construction that I can crowd into one drawing, and which is further illustrated in more or less detail in the other drawings. First of all, I take the worst part of it, the closet, which is in the middle of the house, and therefore the soil-pipe must be in the middle of the house also. The soil-pipe joins a drain underneath the house, an old brick drain, or a series of pipes which, being badly jointed, leak at every joint, and make a cesspool underneath the house. Then, to make matters worse, there is a cistern in the roof which feeds the closet, and the overflow of the cistern goes into the soil-pipe, so that the soil-pipe is really ventilated into the roof of the house, and it is ventilated just over the surface of the water, and very likely the drinking water is drawn from that very cistern. You should not draw your service water for the house, least of all drinking water, from a cistern that supplies the other arrangements. Here, again, is a bath-room showing that it is possible to get wrong in three points in a bath. This bath has a waste pipe going into the main soil-pipe which is untrapped, it has an overflow pipe which is untrapped going into the same soil-pipe, and it has a little tray for catching the drip water which is untrapped, so that in three points that bath must go wrong, especially if these pipes are not taken into an open gully outside, but into the drain. Underneath the houses in Leeds, I do not know whether it is common in London, we very often find a rain-water cistern. There was no good public supply of water formerly in Leeds, and therefore they put a tank for rain water beneath the houses, and of course the washing of the dirt from the roof and the gutters all collected in this tank, and in time decomposed and became putrid, and you had a supply of putrid water underneath the house. Not only that, but the tank would get too full sometimes, and it was not uncommon to take the overflow direct into the drains. There again you had through the tank a direct

communication by which the gas of the drains comes into the water, and through the flags into the houses. Then there is another caution I must give you, and that is this, the rain-water cistern is fed by one of the fall pipes, and that pipe very likely opens near a bedroom window; if the fall pipe goes directly into the drains, you have then a means by which the gases come up that pipe direct from the drain into your window, and illness has frequently resulted from that cause. So that you see you have to make your house absolutely independent of your drains, and if you are building a house anew, it is a very easy and simple thing to do. Architects used to take the longest course, and the most expensive, for all these arrangements, and to make all sorts of things under the house which were difficult to get at, dangerous in the extreme when first made, becoming more dangerous as time went on. Having thus laid down these principles, I will sum them up in one of the sanitary maxims which I drew up for the International Health Society, and which they circulate at a very small cost. This sanitary maxim which contains a great deal of the duty of a householder is this: "If you are building a house, or, if you can achieve it in an old one, let no drain be under any part of your house. Disconnect all waste pipes, and overflow pipes from the drains, and place the soil-pipe outside the house and ventilate it."

In Leeds, and many of the large towns, new buildings are constructed under very strict local bye-laws. You cannot in Leeds put a drain under any building you are making, except under very strict permission from the Building Committee of the Town Council, after sufficient reason given, and then you are bound to lay your drains under the building in the most strict way in concrete. You cannot put a waste pipe direct into a drain. You cannot put an untrapped waste pipe into a sink. Now all these laws are so clear that no town would hesitate about adopting them, and they are carried out in most of the great towns, yet the absurdity of all is this (and as far as any lecture of this kind can make people think and influence public opinion, I hope

mine will do so), that if you go twenty yards out of that district which has these bye-laws, you are very likely in a rural district where people may build houses just as they like, violating every known principle in the most atrocious manner. Some day I hope that is what is good for these towns will be compulsory for the whole country. As you know, I am not a very strong advocate for compulsion, but when a thing is very clearly right and is for the protection of the public, what is clearly right ought to be insisted upon, and to be compulsory.

Now let me come to another point, that of wells and drinking water. Towns, as a rule, are well supplied with drinking water, but villages and smaller towns are as yet dependent on their wells, and that is a very serious problem for the country. I have put up a drawing there showing the danger from a well being very near to a cesspool, the pipes are badly jointed, sewage soaks against the wall of the well, trickles through the bricks and gets to the bottom. In these wells I am told you can often detect drainage soakings by marks on the walls, such as I have drawn there. One gentleman wrote to me a few months ago to tell me what he had discovered. He lives in one of our Yorkshire country houses, and the water being unsatisfactory, they went to the bottom of the well to see what was the matter. They brought up bucketfuls of the débris of rabbits, and this was the history of the pollution of the well. A rabbit run led to a ledge in the well, and the ledge would just hold three rabbits, but if six rabbits in a fright ran in, the first three must tumble into the well and be drowned, and so, for fifteen years, as he said, the rabbits had been perpetually committing suicide in the well.

I have spoken hitherto chiefly on the principles of construction, but I must now shortly touch upon faults of execution, and these faults come both from ignorance and rascality. I do not know whether it is always ignorance or rascality when workmen having to make a bend in a drain, instead of getting a proper curved pipe, go and get a lot of straight pipes and put them together, and think

the water will flow through them. It may sometimes be ignorance, but I think it is often laziness, and sometimes it may be done to save expense. This picture illustrates another way in which the drains go wrong. Pipes may be good, and the workman may have done his work honestly as he thinks, but he has laid the drain on ground which has been recently disturbed. You know how ground sinks when it has been disturbed; when a drain has been laid in a street for some months, a little settling goes on, but if that settling goes on underneath the drain, the pipes gape, and the drains are spoilt. There was a custom, I hope it is extinct now, of using what are called "seconds" pipes for drains, that is to say, faulty ones which the builder buys more cheaply, with bits chipped out here and there. Such drains are useless, they leak at every joint, and a drain that leaks is no good whatever. The object of this kind of drainage is very different from that of agricultural drainage. They should keep in everything, and take it away to the spot where it is to be delivered, whereas agricultural drainage consists of a number of little tubes loosely adjusted together, not merely to conduct water that is already inside, but to allow the outside water to leak into it; and I believe a great deal of our faulty drainage is the result of the misteaching that our workmen get from agricultural drainage. Then again when plumbers used to join together two pieces of lead soil-pipe, they would sometimes, instead of putting in good expensive solder, use putty or soft stuff that soon gave way, that you could put your finger or knife through, that soon cracked, and then the pipes leaked into the house. That also shows the danger of having soil-pipes inside the house. Another point, partly of mismanagement, and partly of ignorance, is illustrated in another picture showing the mischief done by rats. It is made to show you how rats will get into the house, although the pipes are pretty good. It is a very common fault, and is often overlooked. The sink there has its proper trap, but when the leaden pipe goes below the floor it is received into an open-mouthed earthenware pipe two or three times

its size, so that there is an open pipe underneath the house letting in the rats, and all the foul gases. I have only too good reason to know the sad results that such things occasion. I have put up another illustration of a kitchen or larder showing the danger which may arise from what is very common, and we had it in our Leeds Infirmary, a grating in the middle of the floor for the purpose of washing it, which led straight into the drain and allowed the drain gases to come into the larder, the result being that the food which is there does not keep properly, and I have no doubt is sometimes made very unwholesome. On another drawing there is shown a row of Gothic villas looming in the distance. In the front men are carting refuse "to make ground." People fill spaces with this rubbish, and sell them for building ground, somebody builds upon them, not knowing anything about the rubbish, and then I have no doubt illness results. There is another illustration of a danger arising from an addition to a house—a billiard-room which was afterwards turned into a dining-room; the architect in building forgot to ascertain what was under the ground, and unconsciously built the room over a set of drains and an old cesspool; typhoid fever resulted, and then of course they discovered the cesspool. Another illustration shows the difficulty people incur from not knowing where the drains lie. The men are taking up stones to look for the drains in one corner whilst they are in the opposite corner. I might give you another illustration which occurred to a friend of mine, a medical man, who having illness in his house, had the drains examined and found they were made to run up hill, and the consequence was they were all filled up solid, and everything that should run from the house was going under the floors.

A few minutes ago I quoted an expression from my lecture delivered in Leeds five years since, in which I said very few houses were safe to live in. Let me give an illustration. The town of Bradford has the good fortune to possess a "Sanitary Association." The second annual Report by the engineer, Mr. Paterson, states that 53 build-

ings were inspected during the year, and a catalogue of the sanitary defects discovered is given, from which I select the following:

		per cent.
53	Buildings inspected	
15	Damp cellars	28·3
16	Defective drains outside	30·0
6	Rubble drains under H.	11·0
28	Total drains under H.	52·0
7	Defective iron gullies	13·0
35	Filth retaining gullies	66·0
49	Fall pipes, &c., ventilating, sewers unsafely	92·0
17	Soil-pipes unventilated	32·0
14	„ „ ventilated inadequately	26·0
32	„ „ dangerously	60·0
7	„ „ leaking sewage or gas inside houses	13·0
18	„ „ inside houses	33·0
26	„ „ receiving waste-pipes	49·0
35	Bath and waste pipes not disconnected	66·0
9	„ connected and untrapped	16·0
10	Closets in centre of buildings	18·0
32	„ defective.	60·0
12	Cistern overflow into soil-pipe	22·0
3	„ „ into drains	5·0
5	„ „ into waste pipes	9·0
6	Disused sinks continued	11·0
23	Dry closets and ash-pits defective	43·0

All these discoveries were made in better houses whose tenants or landlords can put them right. What of the acres of cottages in our large towns many of them built ten to thirty years ago? Hundreds probably have untrapped sink-pipes passing direct into a drain, or even trapped pipes passing into a drain pipe with unsealed open mouth passing just out of sight beneath the floor. Numbers have badly jointed fire-clay drains running under them—a common sewer for the whole row. In such houses there is illness and ill-health—wounds do badly—and confinements prove fatal. Why do we let such mischief go on?

Contagious Fevers.

When scarlet-fever breaks out, what is to be done? In the houses of the poor no doubt the best thing for patient,

friends, and the community is removal to a fever hospital. Those inhabiting many-roomed houses will devote one room perhaps to the isolation of the patient and attendant. As a rule this will be in the upper part of the house, a situation which involves many difficulties and inconveniences, and some imperfection of isolation. To those who can adopt it let me make a suggestion. Its adoption will be possible to most who live in country and suburban houses. Devote to the patient a downstairs room to which access can be obtained through the window. The rest is easy. Paste up the door of communication with the house, and let all supplies of food, water and coal pass through the window. Further advantages follow. The nurse can take exercise out of doors, when the condition of the patient permits. The patient can be seen by parents through the window, and all communication with the house can be effectually cut off. Architects also in planning a house might well bear in mind the contingency of infectious illness, and not unfrequently make provision for it.

Keeping of Food.

Two points need care in reference to the larder—one, be very watchful that no soil-pipes pass down the wall of the larder, and that no pipe communicating with drains opens either inside or outside near the larder window. The other point is, exclude dust. Dust blown from the street is not only objectionable, but may contain germs of disease. Dust may be practically excluded in two ways, either by admission of fresh air through a filter to be spoken of presently, or by placing the food in cupboards, the doors of which are panelled with canvas or bunting. The panels should be movable so as to be removed periodically and brushed. The pervious canvas allows the air, under changes of temperature and barometric pressure, to pass in and out and arrests the dust. As a proof of this constant passage of dirt-carrying air into closed cases, let me show this mass of blackened cotton wool, which has

filled a tube six inches square passing into one of the large glass cases of the Museum of the Leeds Philosophical and Literary Society. It has been in the tube for three or four years, and is part of an experiment which I have never thoroughly carried out.

I have also been informed that in ice safes the introduction of a cotton-wool filter into the ventilating pipes improves materially the "keeping" of the meat.

Water Supply.

Few questions affect the health of the community more deeply than the water supply. Happy the town and the village which has a public supply of pure water, happy the house that can draw water constantly supplied, for food purposes direct from the main. The uncertainty as to the purity of wells, and the ever-present danger of pollution, renders this a question of national importance, pressing for solution in country places, and demanding every aid from the legislature that is in its power to confer. Surely the rainfall of the kingdom is the property of the nation, to be stored, economised, and used in the widest sense as national property, in trust for the lives and health of the people.

How to ventilate without admission of dirt.

The question of exclusion of dirt is, in towns at least, inseparable from the question of ventilation of rooms. It is unquestionable that, in London for instance, it would be well if every bedroom and sitting-room window could be left open day and night during summer weather. It is no less unquestionable that for such a comfort, so severe a penalty would be incurred by the admission of dust and soot that most householders would deem the privilege too dearly purchased. And yet the thing can be done. It is done in my chambers in the centre of smoky Leeds. An opening in the wall about five inches by sixteen, admits air into a broad tube, in which is placed diagonally a canvas screen exposing a filtering surface about ten times the area

of the section of the opening in the wall. This has never been closed for the last three years. In summer, when there is no fire in the room, and the outer air is warm, the door in the front of the screen is left open. In winter, when the fire draws the air, and the air is cold, the door is shut, and the air is admitted into the room near the ceiling through a Harding's diffuser, fixed at the top of the tube containing the screen. Such an apparatus has been in use in my consulting room, summer and winter for four years, and I have never yet suffered from a draught. The Harding's diffuser is a patent, the rest is unpatented, and open to everybody to use. Unfortunately it is not exhibited, and I cannot do more than show you this drawing.

How to use coal effectively and economically.

Now I come to the question of the economy of coal. Adequate warmth contributes not only to comfort, but to health. Fires not only warm a house, but aid materially in its ventilation. Hence the introduction into this lecture of the question of economy of coal needs no apology. During the last two years I have been doing my best to persuade the people of this country to save a fourth of the coal used in house fires, or at any rate to get a fourth of increased warmth out of the coal they use. This can be done by the improved construction of new fireplaces on principles which I have laid down, but, what is better still, existing ranges can be made slow burning and better heat-producers by the adoption of the contrivance which I have called an "Economiser," which can be made, not only at a moderate cost, but (being unpatented) by any ironmonger or blacksmith. Messrs. Nelson of Leeds show, in the Exhibition, ranges which illustrate the rules I have drawn up, and they have also, to oblige me, shown samples of Economisers, as patterns for those to copy, who care to take the trouble. These economisers are simply movable shields which box off the chamber under the grate, and attain two objects. They cut off the draught from the bottom of the fire, producing slow combustion, they keep the chamber

under the grid hot, and so produce a bright and cheerful fire.

The lessons I would especially enforce to-day are—

1. That advance of knowledge tends to simplicity.

2. That simplicity, which is the expression of a right principle, leads to economy.

3. That it is no economy to have work done badly or with inferior materials.

4. That the best security for good work and good materials (the truest economy) is that the employer shall himself have a knowledge of what is needed both in design, workmanship, and material, and see that he gets it.

5. That, at a moderate cost, and by acting on simple and easily tested principles, new houses, at any rate, can be made, not only free from sanitary defects, and so *healthy*, but also warmer and less draughty, with a reduced expenditure on fuel, and therefore more *comfortable*, more free from soot and dirt, and therefore more cheerful and *economical*.

Let me now conclude with a short quotation from a leading article in the *Times* of June 16.

"Sir Henry Acland took the proper tone when he reminded the Conference last Tuesday of the necessity for economy and simplicity. Common sense will insist upon striking a rough balance of risks and cost of prevention. It is important therefore to keep down the cost, whether in money or trouble, and, in Sir Henry Acland's words, to teach people how little is very often required to make a house decent and safe without imposing upon owners or occupiers costly things which are difficult to procure, and complicated things which are difficult to maintain."

The CHAIRMAN in proposing a vote of thanks to Mr. Teale, said he could fully corroborate some of the things which had been said from information gathered from friends of his own as to the evils they had discovered, in their own houses in London, which would no doubt astound and horrify visitors from the country. He would simply give one illus-

tration of a right hon. gentleman, a Privy Councillor, who occupied at one time a high position in the Government. Having some doubts about the healthiness of his house, he insisted on an examination being made, and found in the basement a most foul and ancient cesspool, which entirely accounted for the state of his throat which had greatly perplexed him, and embarrassed his friends in the House of Commons.

The vote of thanks was carried unanimously.

HEALTHY TOWN AND COUNTRY HOUSES.

BY

W. EASSIE, C.E.

VOL. III.—H. L.

JULY 28TH, 1884.

A LECTURE ON HEALTHY TOWN AND COUNTRY HOUSES.

By W. EASSIE, C.E.

A NUMBER of books, many treatises, hundreds of papers and almost numberless articles have been written upon Healthy Houses, and treated with more or less completeness, and the cry is still they come. I am afraid that thousands of more advents of literature of this kind will have to be encountered by the reading public before the boundaries of even the rudiments of sanitary science have been reached by them. The public generally can master the chief laws which rule the healthiness of a dwelling, but I am afraid that very few have either time or inclination to perfect themselves in all the details which surround each separate law, like so many satellites. Tradesmen themselves, who have for years past been in the habit of carrying out sanitary work, have very much to learn, and as Examiner in Plumbing to the City and Guilds of London Institute, and having to set the "questions," I am able to state, that there is a most lamentable ignorance extant with reference to the great essentials in the healthy treatment of a house, these essentials being succinctly comprehended under the heads of disconnection and ventilation of drains, and the utter separation of the drains from all communication with the water supply.

I will attempt to treat my subject, on the present

occasion, in a novel manner, and instead of formulating under divers heads the various subjects necessary to be observed in order to achieve healthiness in a residence, I will ask my audience, or readers, to visit a couple of houses with me, in the mind, attempting, as much as possible, without wasting time, to give a bodily illustration of the houses by means of diagrams, and some little verbal explanation.

I must necessarily choose a medium-size class of house, that is to say neither a cottage, a very small villa or a large mansion, but rather a house, the counterparts of which may be seen in most of the middle-class residences in towns and cities. It may be taken for granted that the faults which I enumerate, and the proper treatment which I shall indicate, apply almost alike to houses of every description.

In asking you to take your mental perambulation with me through the houses which I have chosen, I will make a point of commencing at the bottom of the houses, in the basements, and after dealing with that throughout, in a sufficiently detailed manner, we will visit the first floor, and so on to the top of the house, pointing out as we traverse each story the common faults perpetrated against sanitation, and the approved means which should be taken to render her a friend.

I would first ask you to go over with me the basement of the first house, which represents an ordinary town house.

Descending the area steps, travelling along the basement passage, we may notice that the stone pavement shows dampness, and also indications of wetness, some feet high in the walls. How can this be wondered at, when, as may be seen, the stone flagging rests upon the bare earth, and there is no ventilating space underneath; the walls in similar fashion show the rising dampness, simply because there is no damp-proof course. Damp-proofing can be achieved by laying down on the wall just above the level of the ground a layer of asphalte, tiles, or slates bedded in cement. As we go towards the back of the house, we

shall see that the end walls are desperately damp through another cause. The dampness here is due to the raised garden at the back of the house, the earth of which abuts on the wall itself and imparts all its moisture to the wall. This moisture penetrates the wall, destroys the plastering, and nothing can prove completely remedial except the introduction of a space between the garden and the wall, with a ventilation between. In this house the stone flooring can never be made dry, the joists and flooring are rotting away, and the servants are suffering from rheumatics.

Let us now look at the second house. In traversing the basement of this house, it will be seen that there is an air space for ventilation, and some distance between the earth, with its concrete cover, and the bottom of the basement flooring, there are also proper damp-proof courses, placed over all walls communicating with the subsoil, consequently, the floorings are never damp, and the boardings never rot, neither does any sickness accrue from damp surroundings. In concluding these few remarks upon dampness, I may add, that nothing thoroughly palliative can be procured in order to keep out the dampness from improperly treated walls, in the way of damp-resisting paints; they have their value, but the drastic method of cure is the best, which means the underpinning the walls, the interposing a damp-proof course, and trenching around the house, where there is a higher level than the basement floor.

Reverting to our first house, a walk through the basement passage reveals a smell, which cannot be traceable to the dampness throughout, but to the improper treatment of the drains. Well, we open them up in two or three places, and find that they are partly brick drains and that the pipe drain portion was laid in the bottom of the old brick drain. We find, too, that the drain has got an insufficient "fall," as it is called, that the brick drain is perished in places, that the subsoil has become saturated with escaped sewage, and that, wherever the drain passes near the wall a foul blackness is added to the ordinary damp

ness, due to improperly-dealt-with foundations. We see, moreover, a number of rat traps about, indicating that the house drain is somehow in communication with the sewer. It cannot be otherwise, for the brick portion of the drain is perished, and the rats have found their way into it, and owing to faulty jointing and the clay luting of the pipes, the rats have formed regular warrens underneath the floor, whence they sally to commit their depredations.

Dogs and cats and traps are all useful in thinning their number, but this constitutes no cure, for by way of their runs, the house is placed in direct communication with the sewer, and is therefore in a consequently dangerous state.

If you look at the second house, you will observe that the drain is a pipe drain, surrounded by concrete, and laid to a good inclination, in consequence of which the drain is self-cleansing inside, and does not permit of escapes at the joints, and is impenetrable by rats.

We return now to the first house, and, owing to a gust of wind, ostensively from the sewer, we discover in the butler's pantry close to the sink, a most disagreeable smell, which has caused the butler numerous attacks of nausea, and compelled him to move his press bed, which was close to the strong room, to an upstairs chamber. In the cleaning room opposite, the same smell is found at another sink, and upon examination, it is discovered that these sinks drain direct into the faulty house drains, without any disconnection whatsoever. Moreover, the bell trap, which is the most dangerous kind of trap ever invented, is in one case clogged up, and in the other cases the covers are broken, and have been removed, thus putting the whole of the basement of the house in communication with the drain. If we now look at the second house we find that the housekeeper's room sink delivers in the open air into a gully before passing into the drain, the butler's pantry sink delivers into another open gully, before passing into the drain, and in a similar manner the cleaning-room sink delivers into a gully in the open area. No D traps are to be seen in this house, and upon exam-

ination it will be found that all the sinks deliver over a proper gully in the open air, besides being trapped, just underneath the sink, by a proper access syphon trap.

Once more reverting to the first house, we find a most annoying smell at the scullery sink—and no wonder, when we find the same bell trap, and the same direct entry into the drain. The grease cannot reach the sewer, but feeds the rats in the drain. I will not enter into the vexed question as to whether grease-collection chambers are absolutely necessary or not in medium-sized houses, but I will contend that where the domestics number more than half-a-dozen, a grease-collection chamber is a positive necessity, and wherever possible, it should be built outside in an open area, and be thoroughly trapped and ventilated —hence the second house has a grease-collection trap in the back-yard. One curse of the majority of London houses is due to the fact that there are no yards at the back, or in the middle of the house, but only the narrow area in the front, with its steps leading into the basement. In the second house, it will be noticed that there are three open spaces, which act as lungs to the basement especially, viz., the front area, the central yard, and another yard at the back.

Having occasion to visit the larder of the first house we encounter a horrible smell, and discover that it proceeds from a bell trap in the floor, which is positively in communication with the house drain, and is not disconnected, and the cook avers that she has always noticed her meat rapidly tainting, and her milk putrifying; it could not be otherwise with a flow of sewer gas into the larder night and day. We find no floor trap in the second house, and we also find that the larder has two good look-out windows into the open back-yard.

On one or two occasions the occupants of the first house encountered a stoppage in their drains, and sent for men to clear it, and they discovered, in the centre of the passage, an old cesspool, which was fairly well cleaned out. These cesspools are very common in all the old parts of towns

and cities, and especially in the west of London, and the utmost care should be taken to make sure that no cesspools exist in connection with the house drain. They will be found in the most unlikely places, under the kitchen or pantry floors, and at the foot of the staircases, and so on. They should be ruthlessly dug up, just as should be the old brick barrel drains of the house, with their sodden subsoil surroundings, and their late whereabouts filled up with clean gravel. The men at this house, when they found the cesspool, were, however, unable to ascertain whether the drain was free from interior deposits, owing to the fact that the drains were partly curved, and that there were a number of right angle junctions without inspection chambers, and they had consequently to lay bare nearly the whole of the drain. If you visit the second house you will see that the drains are in straight lines, and at all places where tributary drains enter the main house drain, manholes have been placed, with covers over, and these have simply to be lifted, and a light placed at the bottom of the drain in each manhole, whereupon, by looking along the bottom of the drain, its cleanliness can be determined.

Whilst examining the first house, we asked for the servants' closet, and discovered, to our horror, that it was inside the basement passage, where it was put when the house was first built, and no one had had the sense to move it, were it only into an area vault outside the house, as did the architect of the second house, where he placed a cleanly wash-out flushing rim basin, in connection with a small flushing tank overhead, which merely required a touch of the depending chain and ring to liberate the whole of the contents.

In the first house which we saw, where the servants' closet was inside the house passage, the closet was a deep filthy hopper closet, with simply a little twirling supply of water, which could never have passed the soil on to the sewer.

We will ascend now from the basement of the first house to the ground floor, and the first thing that salutes us is a

smell in the passage, in the neighbourhood of the water-closet. There is no ventilation to the room in which the closet is placed, and moreover, as if this were not sufficient, the most filthy pattern of closet in the universe has been chosen; viz.:—a pan closet. The closet, all that can be seen of it, is shown by the pan, and below the seat, there is the cast-iron container, and below that again, the D trap. The container is nearly always filthy inside, and the D trap loaded with ordure, and when the handle is lifted up, the foul air in both salutes the nose, often dangerously. This will not, however, account for all the smells, for as may be seen the soil pipe is not ventilated, although trapped at the foot, and inasmuch, moreover, as the cistern above the closet has its waste-pipe communicating with the D trap of the closet, there is a highway formed into the closet room, seemingly made on purpose for the foul air. The water is therefore poisoned in the cistern, and inasmuch as this very cistern overhead the closet, which supplies that closet and the servants' closet below, has a draw-off tap to the butler's pantry sink, no wonder the butler was complaining of sore throat until he ceased drinking the water from his tap. If we look now at the second house, we will find that the closets, four in number, are not in direct communication with any cistern, but have each small disconnection cisterns overhead each water-closet, which enables clean water to be supplied to the basement. The first house has no pure drinking water anywhere in the house; for we find that in a similar manner, the scullery sink derives its water from the large cistern on the roof, and that this same cistern supplies another pan closet of abominable pattern, and the waste of the cistern is moreover into the waste of the closet. This horrible state of things cannot be found in the second house, for here the cistern supplying the most of the basement sinks is situated in the open air, upon a flat, only properly covered, and not in a sooty, dusty roof space; it supplies no closets direct, and has, moreover, its waste delivering into the open air. There is also a separate cistern for the scullery sink,

with draw-off taps in the yards, so as to keep them clean. The closets, too, are not of the bad pan pattern, but are cleanly valve closets, without huge containers and filthy D traps. The waste of the lead trays underneath the closet, in case of leakage of the valves or service, deliver properly in the open air.

We will now mount to the Second Floor or drawing-room floor of the first house, and here we find no closet. But on opening the sash, in order to stand on the balcony to look at some flowers there, our nostrils are outraged by a horrible smell, and on investigation we find that the rain water which descends upon the balcony is led into a rain-water pipe, and this rain-water pipe is not disconnected in the open air as it ought to be, but descends into the foul underground drain; nor will the smell be cured until the balcony is drained into a rain-water pipe which is disconnected over an open gully in the area, the same as is seen at the foot of the pipe in the second house.

We now walk up to the Second Floor of the first house, and we find there a bath with a sink opposite it. This bath has proved such an intolerable nuisance in times past, that it has been shut up for some time, and it has been hinted that an attack of typhoid fever resulted to one of the inmates of the house, whose room was opposite, and who made daily use of the bath. What wonder that such should be the case, when we find that the waste of the bath and the waste of the housemaid's sink opposite, both deliver into the soil pipe by connection with the filthy pan closet? The greatest wonder is, that all who used the bath, and each housemaid who used the sink, did not similarly suffer, for a delivery into an unventilated soil pipe is the most dangerous of all waste deliveries. In the second house the bath is placed on the Third Floor back, and the housemaid's sink above it, and both of these deliver down separate pipes, and eventually discharge over a ventilated gully in the central yard.

Alongside the housemaid's sink on the Fourth Floor in the second house (which sink is only a draw-off sink, down

the outlet of which only the cleaner wastes pass) is a proper housemaid's slop sink, for the reception of chamber slops, and this descends by way of the ventilated soil pipe. In all large houses, there should be such a slop sink, and it is improper to make use of the ordinary draw-off sinks for emptying away chamber slops. The difficulty is, where to draw the line, as to where a separate slop sink is necessary, and I would counsel that, where there are three bedroom floors, one of them should be so especially accommodated ; in a house with two bedroom floors, the slops could be emptied down a proper closet, always provided the slops did not overflow between the seat and the run of the closet basin. It is for this and similar reasons, that the wooden framing around all closets should be so arranged that it could be taken down at a minute's notice, and any overflow of basin in the safe detected. All the upper closets in the second house are so treated, whereas the closets in the other house are not only without a lead safe under each apparatus, but it would take us nearly a quarter of an hour to get out all the screws. In the first house on the Third Floor is the housemaid's closet belonging to that house, and its waste-pipe actually delivers under the trapping water of the filthy D trap of the closet, the same as did the housemaid's sink below.

We will now venture up to the top floor, that is to say the Third Floor of the first house, and there again we feel an unpleasant smell, which would prove serious to a sleeper not inured or acclimatised to it so to speak. This smell is found to arise from two sources, both being from the foul unventilated drain. The rain-water pipe, for instance, has been made to ventilate the drain, and is not disconnected at the foot over an open gully as it should be. In consequence of this faulty arrangement, the drain gases deliver at the top of the main rain-water pipe, which is about level with the top of the bedroom windows, and when these windows are open for purposes of ventilation, these foul gases from the drain are sucked into the warm room, and breathed by the sleeping inmates. The foul

odours given off by the improperly treated trumpet-mouth waste are also sucked into the rooms through a badly-closing manhole leading to the space in the roof. This improper ventilation of the drains, by means of undisconnected rain-water pipes, has slain, to my knowledge, a number of valuable servants who have inhabited the uppermost rooms.

After visiting the first house and observing the faults which are there rampant on every floor, and after subsequently visiting the second house where prevails an entire immunity from smells, one naturally asks if the first house would be properly treated if the underground drain were pipes surrounded by concrete, if the rain-water pipes were disconnected, if the sinks delivered in the open air, if the soil pipes were found sound after testing, by any of the known systems, and were ventilated full sectional area to the roof as they ought to be, if the closets were immaculate in pattern, and the cistern supply all that could be desired, whether the first house could be made equally healthy as the second house. To this question I most unhesitatingly answer No, because there is not a proper disconnection chamber, with fresh-air inlet, between the house drain and the sewer. If you look at the first house you will find in the area vault, what is called a dip trap, which is intended to cut off the house drain from the sewer, but does not do so, because such a trap as may be seen is a veritable cesspool ; and taking into consideration the manner in which our London sewers, at least, are ventilated, it would be better to rely upon an ordinary flap-trap at the end of the house drain, where it enters into the sewer, than to place faith upon such an abominable makeshift as this.

There is one sound sanitary rule, with regard to the underground drains, which is steadfastly adhered to by all competent engineers, architects and builders, and that is, always to provide for a constant current of fresh air throughout the drains. This cannot be achieved with a dip trap such as that in the first house, but only by the interposition of a proper syphon trap, such as that seen in

the front area of the second house. For an ordinary house of small size, and especially where the main drain is not deep, an ordinary disconnection syphon, with an inlet for fresh air on the house side will suffice ; but for deep drains, and for large houses, it is best to build a proper disconnection chamber in brickwork, which can be descended when the usual inspection is made by the man in charge of the drainage, or by the sanitary inspector. A built-up chamber of this description, was supplied to the second house and an inlet pipe of fresh air is brought underneath the paving, because an open grating in the area, at pavement level, would be apt to be choked with dust. In a country house, where there is room, the air would be preferably taken in at the level of the ground, and then it would be delivered by way of an open channel up the house drain, whereas the soil would pass in the opposite direction, through the syphon and on to the sewer—the trapping water in the syphon barring the passage of any gas from the sewer, by reason of its sufficiency of hydraulic seal or trapping water. The fresh air thus taken in at the inlet pipe of the disconnection syphon, or at the open channel of the built-up disconnection chamber, would be taken in constantly day and night, and would be as constantly discharged, by way of the full-sized continuation of the soil pipes. At the end of each ramification of the drain, special ventilating pipes would be necessary in all likelihood, and as all would be untrapped at the foot, the air taken in at the disconnection chamber would be perpetually discharged, and thus all cause of smells due to stagnation of air in the drains would be obviated.

Country houses, which have not been redrained on modern sanitary principles, generally exhibit the same routine of blunders and mistakes as we have noticed in the first house. They nearly always fail as regards healthiness, owing to the drains being connected with an unventilated cesspool or a long outfall drain, without any interposed disconnection chamber. The drains of country houses are also generally of brick, large enough to

drain a village or a small town, and unless these be ruthlessly gutted out and suitably laid pipe drains put in their place, with everything disconnected in the way of sinks, baths, lavatories, cisterns, rain-water pipes and tanks, there will be no health in the house. There is one law which should always be borne in mind, and if properly conceived and carried out, it will form the key to all the other minor matters which regulate the drainage of a house. That rule is this :—disconnect everything whatsoever from the house drain, except the soil pipe or any ventilating pipe, which latter pipes should be of full sectional area, and take care that the house drain has a proper disconnection chamber between it and the outfall drain or cesspool. If there be a cesspool, ventilate it, but not against the house building, and if the drain be a long one, make frequent air inlets into it.

All the restrictions made in foregoing paragraphs in respect of water supply are in full force with respect to the water supply of country houses. In the latter, however, the supply is generally from wells, and these are very frequently contaminated, by infiltration from neighbouring cesspools, and by the ooze from faulty drains. The safe rule with regard to the water supply of country houses, especially where wells are in vogue, is to suspect the purity of the water, until by examination and analysis it has been placed beyond reproach. It should also be borne in mind with respect to houses in the country, that cesspools can only just be tolerated, and that there is no positive necessity for them. Irrigation or sub-irrigation of one kind or the other, is fast prevailing in country houses, and at the present moment I am largely engaged in the abolishment of cesspools, and the substitution of irrigation ; the details of which have been explained by me elsewhere.

By way of conclusion, and still dealing with a country house, I exhibit a plan of the ground floor of a country house, which I designed, and which I had erected on the best known principles under my own personal supervision, at a cost of some £10,000. It will be noticed that all the

drains are taken outside of the house, and that no soil drains pass underneath the house; that the drains are laid in straight lines, and that manholes, in order to secure periodical inspection, are placed on the line of the drain. The hall lavatory, and billiard-room lavatory deliver over gullies in the open air, and have moreover traps underneath the basins, in order to overcome the smell from the decomposing fats of soaps. The bath upstairs likewise delivers into an open gully, as does the butler's pantry sink; the main soil pipe is ventilated full sectional area to roof, as is also the soil pipe from the ground-floor closets; and it will be noticed, that all the closets are distinct from the body of the house. The billiard-room closet, and the servants' closet, are virtually in the open air, and the family closets are also cut off from the house proper by ample window ventilation. Above all, a main inspection chamber is built, so as to reach the whole of the drains, and beyond this is a proper dis-connection chamber, separating the house drain from all other drains, and especially from what acts as the main sewer.

I have completed my few remarks upon proper and improper house drainage, and I trust that the method of illustrating the points which I have chosen have been fairly understood by my audience.

At the conclusion of the lecture, in reply to several inquiries addressed to Mr. Eassie from the body of the meeting, he said that cisterns ought to be covered for many reasons, but not entirely closed up, because the water required a little aëration. He had, in fact, tried closed cisterns but not with good results. Of course ventilating pipes would palliate matters, but from his experiments he thought that tank cisterns would freeze quicker than others. With reference to cowls, it had happened that he, with Captain Douglas Galton and Mr. Rogers Field, had been appointed by the Sanitary Institute of Great Britain, as a committee of three to examine into the subject of ventilation, and the conclusion they had come to at

present was, that no cowl was necessary for soil-pipe ventilation. At the same time he might mention that he had been enabled at a place some distance in the country, to cure certain defects by means of a properly constructed ventilator of the kind, but had he been nearer home he might have been able to remedy them without using a cowl. Cisterns for household supply should, where possible, be placed out in the open air, not inside the house or on the roof. The system of placing them in roof spaces was execrable. He would place them on the shady side of the house towards the north, and of course the overflow pipe would be in the open air. Builders were very remiss in these matters, and simply to oblige the water companies they merely put an overflow pipe at the top of the cistern. He would recommend also a trumpet-mouthed pipe properly disconnected, so that it could be properly cleaned out. The standing waste from cisterns ought not of course to be inside houses. Where that was the case it was not always easy to tell where they led to, and sometimes the traps might become dry and cease to act. Mischief of that kind of course could not happen if the cistern and waste-pipe were in the open air. He had had some experience of the action of frost in Scotland in the case of slate cisterns, and he found that by simply placing a little sawdust round them he could prevent any annoyance from that source. The other thing he could recommend would be a casing of wood. Inodorous felt might be used; but a wood lining was the best thing to use outside. It was not the cistern which required protection from frost so much as the service pipes, and the best plan to adopt was to put two or three folds of inodorous felt round them. That would fulfil all the conditions necessary. If the smaller closet cisterns were furnished with ball-valves they were perfectly safe, and the larger cisterns for household purposes could also be made safe by the same means, and could be easily and quickly emptied. Some of the large London cisterns had never, he believed, been thoroughly emptied for a dozen years, and there was really no pure

water to be got from them. It was simply drawn off in driblets at various times and there was always the same kind of water bubbling up. When they got the constant service supply that would all be remedied and then smaller cisterns could be used.

With regard to the use of inlet ventilating pipes of disconnection chambers, it might easily be understood that when a delicate apparatus was used at the end of a pipe which could not be got at, it would be almost impossible and useless, because it would be perpetually clogged up. If an open grating for instance were put in, it could then always be seen whether it was clean or not. It was advisable to throw all the water from bath-rooms into gully traps, but the pipe, although it would deliver into an open gully, would require a passage of air through it, as soaps were now made of such peculiar fats and oils, and on their decomposition they formed a most unpleasant slime inside the traps. A case was mentioned of a bath-pipe where the soap had collected in a long, stringy, glutinous mass, and it was to prevent unpleasantness of that kind that such pipes and others which delivered from housemaids' sinks were left open both at top and bottom.

The meeting then terminated.

FOUL AIR IN HOUSES.

BY

PROFESSOR CORFIELD.

FRIDAY, JULY 4TH, 1884.

A LECTURE ON FOUL AIR IN HOUSES.

By PROFESSOR CORFIELD.

Dr. HERON in the chair.

THE CHAIRMAN: Ladies and Gentlemen, in the absence of Sir Philip Cunliffe-Owen, I have been asked to take the chair on this occasion, and as you have come here to listen to Dr. Corfield, and not to me, I will not detain you a moment, but simply introduce to you Professor Corfield, who will deliver a lecture to you on "Foul Air."

PROFESSOR CORFIELD: Mr. Chairman, Ladies, and Gentlemen, after thinking for some time about the subject I should take for this lecture, I have thought it better to take some subject which would be practically interesting to a large number of people, and I have selected one in which everybody ought to take an interest, although in some degree, perhaps, not a very savoury subject.

In the first place let us consider the impurities which get into the air in houses from the respiration of the human beings in them. The air that is breathed out is, as we all know, not of the same composition as the air that is breathed in; it has lost some of its oxygen, and it has gained carbonic acid, which is poisonous, and also a certain amount of organic matter and moisture. This air is irrespirable, you cannot breathe it again; that is to say, that air which

contains a diminished quantity of oxygen, and an increased quantity of carbonic acid, together with the other matters I have mentioned, is irrespirable. But that of course is not the air that we generally find in buildings, or we could not live in them. Let me bring before you the results of breathing air that has been breathed before, but mixed more or less with fresh air. I will take, as an instance, one of the worst examples on record, the Black Hole of Calcutta. In the Black Hole of Calcutta, on June 20th, 1756, there were placed 146 persons. The Black Hole was a little place, measuring about eighteen feet each way, with two windows strongly barred. These persons remained there during the night for about ten hours. That space would be equivalent to rather less than forty cubic feet of air for each person. Some who were near the windows got a certain amount of air, and after the first hour or two, small quantities of water were given them; and so they remained during the night. The result was that of the 146 persons who were put into that place, 123 were found dead in the morning, and the 23 survivors broke out in boils all over, and had what has been described as a high putrid fever. That shows you the result of breathing air which is highly contaminated with the products of respiration. Air which has become highly contaminated in this way affords a nidus in which the poison germs of typhus fever grow. That is a fever which is specially characteristic of overcrowded places. It is the fever which used to be called "Gaol fever," from which in former times so many prisoners used to suffer; a disease which they used occasionally to bring into court with them from the prisons, giving it by contact with their clothes to the gaolers and jurors, and even the judges themselves used to be attacked with it: so that the courts had to be closed. That is a fever which affects places in which the atmosphere contains a very large proportion of the products of respiration, and it is a fever, which not only is characteristic of those places, but is being abolished, as we abolish overcrowded places: wherever we are getting rid of the overcrowded dens in which people live, typhus

fever is being abolished altogether, and very soon it will be a thing of the past. Typhus fever when it is taken from a crowded place to a place which is not crowded, although a highly contagious fever, does not spread. I have never known an instance where it has been brought into a house where there was no overcrowding, of another case being found there. So that it is evidently a disease which is not only characteristic of overcrowded places, but it will not flourish anywhere else. But when the air is in this condition, there is another disease which is very prevalent, and that is consumption. That disease, in this connection, has been noticed by many medical authorities; but more notably by Dr. Guy. Dr. Guy mentions the case of a printing establishment, in which the workers had only just over 200 cubic feet each, and they died in it from consumption, just as if it was some contagious fever. Those are the diseases which prevail in houses where the air is breathed over and over again.

Now, let us see what is the reason why those diseases prevail in such air, and what is the reason why air which has been breathed is unfit to be breathed again. What is the reason why the air of rooms containing a considerable proportion of air that has been breathed is unwholesome? Because it is quite clear that it is unwholesome. Well, in the first place, is it the diminution in the quantity of oxygen in such air? As a matter of fact, taking the oxygen in the outer air at 2096 parts in 10,000 parts of air, the oxygen in the air of exceedingly bad ventilated atmospheres is only reduced to 2080 or 2075. You may find in very rare instances, in excessively badly ventilated rooms, that the oxygen is reduced to 2070. So that really the diminution of oxygen is exceedingly slight, and it is a diminution which can in no way account for the results of breathing such atmospheres. The diminution of oxygen then is not competent to account for the results. Then, in the next place, is the increase in the quantity of carbonic acid, of which so much has been heard, sufficient to account for the results of breathing such atmospheres?

On the contrary, the increase of carbonic acid, which is found even in the worst ventilated atmospheres, is so small, that it is in fact a matter of no importance. Carbonic acid, although a poisonous gas, is not by any means so poisonous as is commonly supposed. Air containing even two per cent. of it is not injurious to anything like the extent that I have mentioned as the results of breathing badly ventilated atmospheres; and when we consider that even the worst ventilated atmospheres only contain about one part of carbonic acid in 1000 parts of air, whereas even two per cent. would be a matter of no consequence, or very little consequence, as far as we can say at present, you will see that the increase of carbonic acid has very little to do in spreading typhus fever and consumption. What is it then that is so deleterious in improperly ventilated places, and which produces these evil results? It is unquestionably the presence of the foul putrescible organic matters in air which has been breathed. Those foul organic matters are a matter of much more importance than the increase of carbonic acid. That was shown to people long ago by an Italian experimenter called Polli. He placed animals under conditions where they would breathe different atmospheres; some he put in an atmosphere in which lime was placed to absorb the carbonic acid and moisture; some in an atmosphere in which charcoal was placed to absorb organic impurities; and some in an atmosphere in which no precaution was taken at all. And it was found that the animals placed in an atmosphere where no precaution had been taken died first; those put in an atmosphere containing lime, which absorbs carbonic acid and moisture, died next; and those in the atmosphere containing charcoal, which oxidises organic matters, died last. So that, by his experiments, Polli long ago showed people the results, at which we have only arrived quite recently, in regard to the contamination of the air by organic matter. I want you to be quite clear in your minds that the increase of carbonic acid is nothing more than of the slightest importance in the question of the deterioration of the atmosphere. At the same time it is quite

true that the amount of increase of carbonic acid in the atmosphere is a very good test of its condition and purity. We are enabled to test that very accurately, in proportion to the amount of carbonic acid present in it; so that it is an exceedingly useful test for us, and it is by its presence that we are able to test the qualities of our atmospheres. Now the atmospheres in inhabited places have been divided by Professor de Chaumont into classes, according to the sensations which are experienced on entering them from the outer air. The first class of atmospheres are those which appear fresh when you come into them from the outer air, and have no close smell. Those are the atmospheres of the properly ventilated places, places in which the organic matter has been constantly got rid of, and has not got to such a point that you can distinguish it. Those are places where, if the carbonic acid in the outer air is taken to be four parts in 10,000, there will not be in the atmospheres more than six parts, or an increase of two parts of carbonic acid. The next class of atmospheres are those in which there is a little closeness observed on entering. Those are atmospheres of the second class, and in them the organic matter in the air, and the excess of moisture, have got to such a pitch that you can detect them on entering the room from the outer air; and I want here to show you how extremely small the increase in the carbonic acid is: because if the carbonic acid in the outer air is four, the proportion in these atmospheres will not be more than eight, that is to say, not more than four parts more. In the third class we find the atmospheres of places in which, when you come into them from the outer air you find the sensation is disagreeable, that is to say, that the organic matter has increased until there is a disagreeable sensation experienced, and the quantity of carbonic acid is again increased. In the next class of atmospheres the sensations become very oppressive; and taking the increase of the carbonic acid as the key to the condition of the atmospheres, it is found that the amount of carbonic acid increases progressively with the

disagreeable character of the sensations which are produced. So that the sensations which are produced upon a person entering a room from the outside, are an accurate guide. Those sensations which are produced upon a person entering a room from the outside atmosphere, tested by the presence of the carbonic acid, are found to be quite accurate; those sensations give you an accurate idea of the amount of the organic inpurity in the air, and that impurity has been tested in the way I have mentioned to you, by means of the amount of carbonic acid present.

From the considerations which follow from this, and from the fact that in atmospheres which are properly ventilated the amount of carbonic acid does not exceed that in the outer air by more than two parts in 10,000, we are able to find the amount of air required by each individual every hour. That quantity is 3000 cubic feet in an hour, and that supply of air is required to keep rooms fresh; and if we require that quantity to keep them fresh, it is hardly necessary to point out that, as no rooms are made large enough to give that quantity, the air in our rooms must be changed. Take a room in which a person sits for several hours, or a bedroom where a person sleeps for seven hours; he requires 21,000 cubic feet of air to breathe, so that he would require a room to be of dimensions such as really no ordinary sleeping room has, nor anything like them. It is quite clear, therefore, that a change of air is necessary; and, in order to keep the atmosphere in houses in a sufficient state of purity for the people to breathe it, we are justified in laying down the law, that if an atmosphere is in such a condition, that a disagreeable sensation is perceived upon going into it, that atmosphere is not properly ventilated, and is not fit to live in.

Now, I am not going to take up your time by describing to you the various methods of ventilation in this lecture, because that belongs to another subject; this lecture being on foul air, and the results from it. I will now, therefore, pass on to consider another kind of foul air, and that is the foul air in houses, which is not produced by breathing.

First, we will take the foul air arising from sewers and drains. In sewers and drains there is always foul air arising from putrescible matters, which get into places where they are not flushed away, and which decompose, producing foul air. The results manifested from the entrance of such air into houses, whatever way it gets in, are to be seen in the appearance of certain diseases. Those diseases are in the first place sore throats and fevers. Sore throats are exceedingly common in houses where there is foul air. Diphtheria is very common in such houses, and scarlet fever is not at all uncommon in them. Diarrhœa and typhoid fever are common for another reason in those houses, too; and besides that, there is a general malaise, a general state of ill-health. A general state of being out of condition is found among people who live in houses into which the foul air from the drains gets. We have now to consider how such foul air gets into houses, or some of the ways at any rate, in which such foul air gets into houses. It gets in through bad appliances; through defective work, or even defective arrangements of good appliances; through over use of things, by which they get worn out (and are not replaced), or by which they get out of order; and still more by the disuse of such things. Now, in the first place the drains themselves are very often made of porous bricks, which allow the foul air to come out of them, and sometimes the foul water too. If the foul water escapes out of them, it is practically the same thing as if foul air escaped out of them; because it soaks into the soil around and produces bad air, which passes into the houses sometimes in very considerable quantities, so that whether you have an escape of foul air, or foul liquid from the drains, it comes to very much the same thing. Drains are very often made of porous materials, and frequently of bricks and mortar, which are very improper materials for them to be made of. They were formerly very properly made of bricks and mortar; because they were intended for drainage purposes, that is to say they were intended to drain the water from the soil, and they were, therefore, intended to be made for

the water to get into them; but when they are to be used as sewers, they ought to be made of impervious materials, so that the foul water which passes into them cannot get out of them. However, they are frequently made of porous materials, or badly jointed; and besides that, rats disturb drains which are made in such a way, they burrow underneath the pipes and let them down, and then they make runs under the floors in such houses, and go in fact wherever they can follow the drains. The presence of rats in a house, therefore, is always to be regarded as a sign that the drains are out of order. Then they are also a source of danger; because wherever rats go the foul air from the drains can follow them, and also rats take a certain amount of filth with them from the drains, and as they generally find their way into the larder, they take that filth, therefore, to any food they come across. Sometimes, also, they get into the water cistern, and pollute the water supply in the same way. So that you see the presence of rats in a house is a sign that the drains are in bad condition, and that there is a means of foul air coming from them into the house. Rats do not always confine themselves to a particular house under which the drains may be defective, but they get into neighbouring houses; and I will give you a curious instance of that which came under my knowledge. The drain in that case was a pipe drain, and the lengths of pipe had been insufficiently joined together; the rats burrowing under the pipes, let one of them fall out of joint, where they had been loosely put together. Then the rats, by means of the drain which they had so disturbed, got into the house. The next thing was that a nuisance was observed in the house, and what did the people do? Instead of taking up the drains and putting in new ones, they patched them up, and then put down a layer, about six inches deep of concrete, all over the basement of the house, from one end to the other. That of course, as far as it went, was a very good thing to do. It is always an excellent thing to have an impervious layer of concrete in the basement; because

it prevents air rising from the ground into the house. I may as well say here, though it hardly forms part of this particular subject, that if you do not have an impervious layer in the basement, houses will be affected by exhalations from the earth; because when fires and lights are burning at night, air is drawn into the house from the ground. That air is not fit to breathe even in the country, and it is much less fit to be breathed in towns. Well, to go on with the instance of the rats finding their way into adjoining houses. It was found that those rats came up through the hole in the drain all the same, the concrete of course did not prevent them going through the pipes; they found a place where they could get under the party-wall, and so they got into the kitchen of the next house. There they burrowed underneath the hearthstone, and made their nests. They came up, you see, out of the drain in the street, where there was no trap to prevent them, got out under the footings of the party-wall, and so into the kitchen of the next house, where they had a very nice time of it. In fact, they ran all over the next house, where the sanitary arrangements had been put into excellent condition. They lived and died there, until something had to be done to get rid of them; the hearthstone was taken up, and then it was found that there were no less than thirty-six dead rats in all stages of decay, in that which had been their living place, and also their dying place. That is a very curious instance of the way in which, if one person does not pay sufficient attention to the sanitary arrangements of his house, he may be the cause of creating a nuisance to other persons, even if he is not a nuisance to himself.

Then again foul air frequently gets into houses quite apart from the operations of rats, from pipe drains being improperly laid. They are frequently laid simply with the joints placed together, or what is called "dry," that is, without any cementing material being used at the joints. Of course when they are laid dry in that way the water runs out of them continually; there is no reason why it

should not, and foul air, too, comes out of them into the houses. That becomes still worse where there is no trap on the drain, which does not of course always happen. Sometimes, however, the pipes are not laid dry, but they are jointed with clay. Now, clay is a very bad jointing material; because it is apt to dry and crack, and it squeezes out with very little pressure on the pipes from the earth over them. If rats happen to get underneath them, in consequence of their burrowing combined with any pressure from the earth above, the pipes get shifted and leakages occur. Again, not infrequently pipes are laid with the joints the wrong way; instead of being laid with what is called the socket end up, they are laid with socket end downwards: and if the joints are made with clay, the clay cracks and squeezes out, the water runs out through the joints, and so the solid matters are left in the drain, which gradually gets blocked up. Even if pipes are jointed with cement, which is one good way of joining them, they may still leak, so that air comes out of them; or, they may be jointed with cement in such a way, that it is done imperfectly: the cement is only put in round the top of the joint, nothing being put underneath. That is not at all an uncommon way with builders of laying pipes, either for the sake of saving a little cost and trouble by scamping the work, or from mere carelessness. Of course the result of that is that, to all appearances, there is a nice well-laid drain; but it is not at all efficient for its purpose, and the consequence is that the foul water, or a great deal of it, finds its way out into the soil under the drain.

Now, it is very difficult to discover these defects, and they can only be found out by plugging the pipes, filling them with water, and seeing whether the water remains standing at the same level in them. If you plug a drain with clay tightly at the lower end, and fill it with water, until you find the water standing in it at the upper end, and then measure the depth of it; if you find it does not remain there, it is clearly leaking somewhere, and you must

find out where it is, or else the whole drain must be taken up and relaid.

Now, I think that will have to be enough in connection with drains, although there are some other points in reference to them which one might mention. I need hardly say, that similar remarks would apply in many cases where cesspools are found underneath houses.

The next things I shall mention to you are dustbins, which are a very fruitful source of disease in houses. They are frequently built against the wall of a house, or the space between the walls of adjoining houses is the place selected for the dustbin, where every kind of refuse is thrown. Foul air is generated in those dustbins from the foul decomposing organic matters, which ought never to be put in them. That foul air passes into the rooms in the basement, and from the basement into the rooms above. I have known very serious results follow from the passage of foul air from dustbins through the walls, right up into the dining or drawing rooms above, arising simply from the fact of the dustbins being placed close against the bricks; because bricks of course are very porous. Another means by which the foul air from that source does mischief, is the existence sometimes of a loose joint in the rain-water pipe—sometimes the joints are not very tight—and the foul air from the dustbin passes up the rain-water pipe, and escapes, perhaps, into the balconies or drawing-room windows. Dustbins ought to be detached from the houses; and they ought to be made of some impervious material, such as galvanised iron for instance, and the large wooden or brick dustbins, of the kind now so generally in use, ought no longer to be tolerated.

Then the next point I will refer to, is that very often connections are made with the drains directly from the floors in the basements of houses. This is very commonly the case in the scullery, and in lavatories and passages. Openings are made leading into the drains; and the object of those openings being made is that when the passage or scullery, or wherever the opening is made, is swilled down, the water may

run down into the drains. This is a thing which should never be allowed, although of course those openings are trapped, with the object of preventing foul air going into the house. But the kind of trap which is most generally used for the purpose, is what is known as the bell-trap, from the shape of the cover of it. Here is a specimen of that kind of trap [producing same], and you would see that not only in almost every area in London, but you would see it in the floors of passages in houses, and in sinks. That, I think, is about the worst form of trap that has ever been devised, for a great many reasons. In the first place it holds a lot of filth, and that generates foul air; the next thing is that it holds very little water, and even that diminishes as it gets full of filth, and as the trap is made only by the bell dipping to the depth of half an inch in the water, when that is evaporated the foul air comes straight into the house: because the trap is gone. Another thing is that when the bell is taken off, as it often is, the trap is of no use. The top has frequently to be taken off, because of these small holes in it getting filled up; and when the place has to be swilled down, it has to be taken up to let the water escape, and it is not so frequently put on again. Once taken off, it may be left off for days, weeks, or months; and I have known numbers of cases of disease and death to occur from that cause. Then again it often gets broken by some accident, the master or mistress is not told of it, and the place remains untrapped, perhaps for years. That is a form of trap which should not be tolerated inside a house, and the only good of it outside, is that it helps to ventilate drains, which otherwise would not be ventilated at all. But neither should a good trap be put in the floor of a house, and connected directly with the drain; it should discharge into an inlet in a trapped gully outside.

It will be most convenient for us next to consider the soil pipes. Soil pipes are the pipes into which water-closets discharge, and they are very frequently placed in improper positions inside a house, and are also made of improper materials. Whatever materials they are made of, they

ought to be placed outside the house; because if there is any defect in them, it is better that it should be outside the house than inside it. One of the commonest and best materials for them to be made of, if they are properly ventilated, is lead; but it is not the best if they are not properly ventilated, because foul air has the property of eating holes through solid lead; and I have got here several extraordinary instances of that to show you. Here is an example [producing a piece of pipe], where holes have been eaten through the solid lead by the action of the foul air. Where that is the case the foul air escapes, and causes epidemics of sore throats in the house, and other diseases are also produced by it. Here is another instance of the same thing [producing another specimen]. This is also a piece of a soil pipe; they are so large here, that you can all, I have no doubt, see the holes which the foul air has produced in the pipe. That was taken out of a house not six weeks ago, in which an outbreak of disease of some kind or other, caused by the defective condition of that pipe, had occurred. This is a still more interesting piece, because it is an instance of a soil pipe, which is ventilated certainly, but in the wrong place. That fact, you see, has not prevented the collection of foul air, and the consequent formation of holes in the upper part of the pipe, and that shows the necessity of having the ventilating pipe at the top. Soil pipes may either be made defective in that way by foul air, or they may be made originally defective with the pipes merely slipped into one another at the joints without anything at all, or with only a little putty, and no proper cementing or soldering. The best soil pipes are made of lead, and if they are properly made and ventilated in the first instance, they will last for years. Iron, also, is frequently used for this purpose; but I do not think, where the pipes are inside the house, it is an advisable material to use, because one can never feel quite sure of the joints. You have to join pieces of lead with it from the closets, and one never feels quite sure of a joint between iron and lead. So that I do not think it is a

good thing to have iron soil pipes inside houses, in this country at all events. I say in this country, because our American cousins insist upon the necessity of having iron soil pipes, and on the necessity of having them inside the house. Now soil pipes, as I have said, are frequently unventilated, or they are ventilated improperly with pipes that are too small, and very often put in the wrong place. The ventilating pipes are carried close to the tops of chimneys, and the foul air from them may be carried down the chimneys into the house. Then they are sometimes made to end too near the upper windows. I have seen them made to end not very far from the nursery windows; and I have known diseases produced among children in that way. Occasionally, no doubt unintentionally, they are actually made to end practically inside the house. I have seen such instances, and those were instances where rain water has been brought into them by gutters, and in that way you occasionally find an open head positively inside the house. I found recently a case in the house, too, of a medical man, where there was always illness in the house; where the open head of the soil pipe, into which the gutters joined, was in a cupboard on the top floor of the house. I had better here, I think, give you one more instance to show you how difficult it is sometimes to find out these things. In a large country house they occasionally found faint smells in some of the rooms. In one of those rooms, called the music room, the floor was taken up, and they went on until they came down to an old drain. They cleared that away, and filled in the ground; but it was just the same as before, it made no difference, so that the smells evidently had nothing to do with that drain whatever. One way of testing how foul air escapes into a house, is by pouring some very strong smelling stuff down the pipes, and then seeing whether it can be smelt in the house. The thing most generally used for that purpose is oil of peppermint; but oil of thyme, and also ether, are sometimes used. When that was done in this case not the slightest smell could be found in any part of the

house which was near to the soil-pipe which was tested, and we began to think it was all right; but as the soil-pipe was unfortunately inside the house, it was examined thoroughly along the whole distance for which it could be seen. There was not the slightest escape of ether from it, and no defect whatever could be found in it. It had never occurred to anybody that any escape from the soil-pipe could reach the music room; but when they went there they found that that room was full of ether, which was what was used in that case. The piece of soil-pipe inside the wall was then exposed, and it was found there was a hole in the pipe inside the wall, where the bricklayer had "made good," as it is called; he had driven his chisel into it, but as he was not a plumber he could not mend it, and he just left it alone. The air from that hole got out underneath the passage, wandered under the floors, and appeared at last in this room, which was on the other side of the passage. That is a very curious instance of the way in which foul air will travel about houses in extraordinary ways. Sometimes soil-pipes are improperly connected with the drain at the bottom, and sometimes they are not connected with it at all; they sometimes simply open into the ground through the floor, and there is a space left for the water to run into a hole left in the drain. I have known that to happen more than once, and it occurred once in my own house; but I need hardly say, it did not remain in that condition long. In such cases the foul matters of course escape and percolate into the soil around, and so foul air gets into the house. There is another thing which I want to mention to you in connection with soil-pipes, which often occurs where they are connected directly with the drain. In a house where the children in the schoolroom were continually suffering with something or other, the drainage arrangements had been, it was supposed, all put right; but it was found that the pipe from a closet passed down under the schoolroom floor, and there was a pipe in the basement leading down into the drain. On taking up the floor, it

was found that the discharge was really made into a space between two arches, so that it formed a sort of cesspool; and in that way actually underneath this schoolroom, where the children had been sitting over their lessons for hours every day, there was simply an open cesspool, connected with the drain.

Foul smells, also, get into houses from bad forms of closet arrangements. I have not time to go into this subject at any length; but I will merely mention to you, that the "pan-closet," which is perhaps more used than any other, is one of the worst forms of sanitary arrangements that has ever been devised. This, which is called the "D" trap, from being like the letter D [showing specimen], is the trap very commonly used in connection with the pan-closet; you may have everything else as right as you like, but if you have a pan-closet in a house, it is certain to be a nuisance, especially if there is a D trap connected with it. This trap, as you can see from its shape, is nothing more or less than a small leaden cesspool, and the water that passes through it cannot possibly clean out the contents from every part of it, and consequently they decompose there and give out foul air, which escapes into the house. Let me here show you one or two other things in connection with this matter. This [showing specimen] is an instance in which foul air has eaten holes in the top of the trap, and it is another instance of an improper sanitary arrangement, which is very common, namely, the connection of waste pipes with the traps of water-closets. One of these came from the housemaid's sink, and there is one, it is not at all unlikely, which came from the cistern. Of course those pipes, which are so connected with the trap of the closet, afford a means for the foul air to escape into the sinks or cisterns, or baths, or wherever those waste pipes come from. Before I leave this subject of the pan-closet, I must mention one thing in connection with it, which makes it so exceedingly objectionable in itself, and that is, that underneath the seat there is a large iron box, called the container, in which the pan, as it is called, is

placed, so that it can be moved. This large iron box is above the "D" trap, and so is always full of foul air, which escapes continually into the house by passing through the small quantity of water in the receptacle called the pan. There is a still worse arrangement in these closets. The container not unfrequently has a small hole bored in it at the top, and when the apparatus is worked foul air is forced out from the container into the closet room, with sufficient force to blow out a candle. That is frequently a very common source of disease, and I have known many cases of houses, with such arrangements, where epidemics of sore throats and other kinds of illness were prevalent. This form of closet arrangement should be abolished, and it really ought not to be tolerated any more. I have mentioned to you the mistake of connecting waste-pipes with the traps of water-closets; waste-pipes from sinks ought not to be connected at all with a drain directly even when trapped; they ought to be made to discharge into the open air, and even then I say, that if they are not trapped under the sinks, you will still have foul air coming into the house. The air that comes in is not from the drain, but you must remember the pipe is a dirty pipe, soap and grease of all kinds go down it, and it is not a proper pipe, therefore, for a ventilator. There ought to be a siphon trap on it, which would hold a little water, so as to prevent any air coming through the waste-pipe into the house at all. Then if the waste-pipes of sinks should not be connected with drains, they should certainly not be connected with soil-pipes, as they frequently are. A very common source of illness is the connection of the housemaid's sink with the soil-pipe. You find not at all unfrequently a very nasty, worse than nasty, smell in a bath, even where there is of course a constant flushing from the passage of the waste water. You will find that to be the case where the air comes in through a long untrapped waste-pipe, and if that applies to a bath, it certainly applies still more to a sink.

Now, rain-water pipes and gutters are very fertile sources

of disease. Rain-water pipes are not unfrequently placed inside houses—in fact they are very frequently placed inside the house. They start away up at the top of the house, and they pass down through the rooms; they go through the bedrooms on the top floor, then through the best bedrooms—I am speaking now of a particular instance within my own knowledge—through the drawing-room, through the dining-room, and a room in the basement, into the drain. Of course it is supposed they can do no harm; because they are intended for nothing but rain-water. Workmen only consider what goes down pipes, not what comes up them. If there is a trap at the foot of such a pipe, it is very little better; but if not, it is as bad as can be. Foul air comes out through leaky joints, which were never attempted to be made tight, into the rooms, and illness is the result. That is an exceedingly common thing, and rain-water pipes, therefore, ought always to be put outside the house wherever they can be, and they ought certainly not to be connected with the drain; but ought to be constructed to discharge over areas, like sink pipes.

Then, with regard to rain-water gutters. They are frequently made inside houses, in order to avoid the appearance of gutters passing along the outside. When they are placed under the roof, but above the ceilings, it is not a very serious thing; but that is not always the case, and it is not an uncommon thing for rain-water gutters to be carried from the front of the house, right through under the floor of the top story, into a head at the back of the house, to avoid having the appearance of a pipe outside. It is an exceedingly common thing for rain-water gutters to be carried in that way. They are leaden gutters, with very little fall as a rule. Dead leaves, soot, and all sorts of things get collected in them—even dead birds are sometimes found in them—and of course where that is the case, it will produce foul air in a house. I have known plenty of instances of disease occurring from sleeping in rooms where the gutters have been carried along inside under the windows. There is

nothing to show what they are, and they look simply like window seats. If you were to take the nails out, and get the top off, you would very likely find underneath what is called a "box-gutter," and you would also very likely find it in a very filthy condition.

The next thing I will mention, is the connection of the waste-pipes, or overflow-pipes of cisterns with the drains or with the water-closet apparatus. They are exceedingly commonly connected directly with the drains, with the D trap of a water-closet, or, perhaps, even with the soil-pipe. Of course that is exceedingly wrong; foul air comes up and contaminates the water in the cistern. And the foul matters so brought into it may contain the poison of enteric fever or of diphtheria; they frequently do so in London. This is a very important point in sanitary arrangements, and though I have mentioned it so late, the connection of the overflow-pipe of the cistern with the drain or soil-pipe is by far the greatest cause of enteric or typhoid fever in large towns. There is no question about it; all other sources of illness from defective sanitary arrangements in houses are as nothing, compared with the connection of the waste-pipes of the drinking-water cisterns directly with the drains. I feel that I need not insist any more upon the importance of this subject, as the remarks I have already made to you upon it are so thoroughly well received, and perhaps I had better at once say, that the way to cure that mischief is to cut off that connection of the waste-pipe with the drain altogether, and make it discharge into the open air. In one case in a house in the country, where a bad smell had been perceived, a plumber was sent for, and he examined the cistern, the waste-pipe of which he found to be in connection with either the drain or soil-pipe. Instead of disconnecting it, he did a very curious thing, which I will try to describe to you. He put a conical piece of zinc over the top of the waste-pipe, and a pipe passing from that out through the roof. It was apparently all right as long as the cistern was quite full. The result would

be that any foul air coming into the cistern would escape up that ventilating pipe, and out through the roof; but as soon as the level of the water went down far enough, there was this beautiful arrangement standing quite dry.

Another plan, sometimes adopted, is to put a small trap of some kind on the top of the waste-pipe. Here is an instance of it [producing specimen]. You can see in this where a small bell-trap has been. As long as the connection remains, any arrangement of that kind would be no protection at all; even a difference of temperature in the cistern would cause drain-air to escape into it, so that that is an exceedingly absurd precaution, and practically useless. There are one or two other matters which I wish to mention which, as I have already taken up so much of your time, you will be glad to know will only take a few minutes. One is that smells are frequently found to travel about houses by means of the tubes in which the bell-wires pass. That is a thing which is not as much attended to as it should be. I have seen some very curious instances in which rooms are often made practically uninhabitable by nothing else but the way in which foul air comes in through the bell-wire tubes. They go through the house from floor to floor, little places are left in the walls for them, and cranks are required, and various little arrangements are made under the floors. Of course there must be a passage made for the wires right down to the bells in the basement. Sometimes the bells are in a little cupboard or recess, near some pipe connection; they may be hung in a place where there is a very bad smell. Sometimes they are put up in the boot-hole. I have known instances of bad smells going right up into the upper rooms from that cause. The products of the combustion of gas rise up and make their escape through these bell-wire tubes, and it is not at all an uncommon thing for the products of combustion in the lower parts of houses to escape ultimately into drawing- and bed-rooms through the bell-wire tubes.

One other thing I must mention, and that is the foul air that is produced by a slight escape of coal gas. That is

another important matter. As gas-fittings are not always perfectly tight, a very slight escape of coal gas from them into the rooms frequently takes place. Where that is the case it produces a very peculiar smell, which nobody would ever suppose was from coal gas. It would generally be supposed to be from drain-air, and it is a smell which is exceedingly difficult to recognise, unless people know what it is. But it is an important matter, and you should always be on your guard against it. Whenever there is any doubt about where a smell comes from in a room, smell the gas burners and the chandeliers. That is the only way to detect it; it is no use applying a light to it, because it mixes with the air much too rapidly to cause combustion or explosion. But you can always smell slight escapes of gas, and where there is such an escape, it is a very serious matter; because coal gas contains one of the most poisonous of substances, carbonic oxide, which affects the corpuscles of the blood, and the presence of a very small amount of that carbonic oxide in the atmosphere of a room is exceedingly deleterious. It is chiefly due to the presence of this substance in coal gas that people have headache, when they live in rooms where there is a slight escape of coal gas.

Foul air from drains not unfrequently passes into the larders in houses through pipes, which are sometimes directly in connection with the street sewer. I know one instance in which there was a bell-trap not connected with the house-drain, but with a separate one going straight into the street sewer. When that trap was examined, it was found to be as dry as this one in my hand is now, and I venture to say that it had been dry for a year. There had been scarlet fever and diphtheria in that house, and I have no doubt that was caused by the foul air getting into the larder from the street sewer, and so of course contaminating the food in the larder. I remember in particular one instance, which I have mentioned several times before, but which, perhaps, I may mention again now, in which there was a bad smell in the larder, and

nobody could suggest how it came there, until it was found that the soil-pipe of a closet upstairs came down inside the wall of the larder. On examining it there, it was found that a nail had been driven into the soil-pipe, and the dish-cloths and larder-cloths were hanging upon it. There are many other instances of a similar kind, which I might give you. I remember one case in which a water-closet opened directly out of the larder; in fact it formed part of the larder when the door was opened. Of course what I have said of larders applies equally to dairies. It is a very common thing to find sanitary defects in dairies, and in that way the milk gets poisoned and produces diseases, which we know now are caused by the poisonous matters which contaminate the milk, in consequence of those defects.

Another thing which is exceedingly dangerous is the disuse of such arrangements as I have mentioned; any sanitary apparatus that is not used is dangerous. I do not care what it is. The traps become dry; the outer air comes in either through dirty pipes or badly made, carelessly placed, or defective apparatus, and you frequently find cases of diseases being caused by foul air coming into houses, simply on account of such pipes and apparatus being disused. I will mention to you one instance of that which occurred in a school, where there was an epidemic of sore-throats. I should tell you that the school-house consisted of two houses, which had been thrown into one large house for the purpose of carrying on the school. Everything had been done that had been advised, and it was supposed that the sanitary arrangements were perfect. But in one of the houses there was a sink, which was never wanted, with a bell-trap and pipe leading down underneath the floor. It had been thought that might be left alone, and that there was no need to do anything with it. The result was that from disuse, foul air came from it, and in fact the current of air that was coming in through the waste pipe of that sink, and through another bell-trap in the floor just under it, would, to use a

common expression, have "turned a windmill," and it had as foul a smell as any drain air possibly could have.

Now, Ladies and Gentlemen, I am afraid I have very imperfectly performed my task, but I have endeavoured to do my best, and I have now finished it. I will only add that here is a specimen you might like to see. I have referred to the fact that rats sometimes eat holes in lead pipes, and this is an instance of a lead waste-pipe, through which a rat has eaten a hole large enough to enable him to get into the pipe.

A vote of thanks was passed to the Lecturer.

VENTILATION

IN CONNECTION WITH

WARMTH AND LIGHTING.

BY

CAPTAIN DOUGLAS GALTON, C.B., F.R.S.

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A LECTURE ON VENTILATION IN CONNECTION WITH WARMTH AND LIGHTING.

By CAPTAIN DOUGLAS GALTON, C.B., F.R.S.

THE CHAIRMAN, His Grace the DURE OF NORTHUMBERLAND, K.G., said, in commencing the business of the meeting, it would not be necessary for him to say more than a word or two on the subject of the lecture which they were assembled to hear. There was no one more cognizant with all the facts, or more competent to deal with them, than his good friend Captain Galton. Ventilation in connection with warming and lighting of houses, was perhaps one of the most difficult questions in practice that could be well propounded, for when they lighted fires they created a draught, and if they did not light them they had no warmth at all. When they used a closed stove the room became tolerably hot, and if they had open fires the consumption of fuel was enormous, and the result to books, pictures, and the like, was simply disastrous. If Captain Galton could lay down any scheme by which the objects of both ventilating and lighting houses could be contrived, he would be accepted as a benefactor, not only by the inhabitants of London, but by the whole country.

LECTURE.

IN this lecture I propose to endeavour to explain what are the principles which should guide us in warming our houses, and then to endeavour to show how those principles can be usefully employed in practice. We must all agree that our present arrangements are inconvenient in certain respects, so far as our towns are concerned.

When we bring a large number of houses together, as we do in our great cities, the methods which we adopt for warming our houses conduce to the production of a very large amount of smoke and pollution of the atmosphere. The amount of coal which we burn is out of all proportion to the heat which we produce. Therefore, in our towns the methods to which we resort for warming our rooms loads with impurities the air which we have to breathe.

Those who have been born and have lived in the heart of London, do not know what the feeling is of breathing fresh invigorating country air. The question is, how can we alter this?

The first step towards alteration is to know what conditions we want to obtain. We will consider in the first place what advantages our present methods of warming secure for us, and next how we can secure these in ways less hurtful to our atmosphere.

The open fire is the most favourite method of warming. So far as the production of heat is concerned, it is also the most wasteful. One pound of coal is more than sufficient, if all the heat of combustion is utilised, to raise the temperature of a room, twenty feet square and twelve feet high, to ten degrees above the temperature of the outer air. Do you know how much 1 lb. of coal amounts to? This is 1 lb. of coal. If the room were not ventilated at all, and the walls were composed of non-conducting materials, the consumption of fuel to maintain this temperature would be very small; but we must change the air of the room if we are to live in it, or else the act of breathing would render

the air so impure that we should die. The air which passes out of the room to make way for fresh air is warm, and carries some heat with it; the fresh air which comes in, if cold, absorbs heat, which brings up its temperature to that of the room. All this entails a development of additional heat. For instance, if the volume of air contained in the room above mentioned were changed every hour, 1 lb. of coal additional would be required per hour to heat the inflowing air, so that to maintain the temperature at ten degrees above that of the outer air during 12 hours, would require 12 lbs. of coal. Besides this there is a continual escape of heat going on through the walls, windows, ceiling: indeed, taken generally, the circumstances of occupation of a room entail a greater consumption of fuel than the mere 1 lb. of coal, in order to maintain the temperature. But the open fire consumes much more than would in any case be necessary to keep up the heat.

The usual plan of the ordinary open fireplace is for the coal to be placed in a grate, to which air is admitted from the bottom and sides to aid in the combustion of the coal; and an ordinary fireplace, for a room of 20 feet square and 12 feet high, will contain from about 15 to 20 lbs. at a time, and, if the fire be kept up for 12 hours, probably the consumption will be about 100 lbs., or the consumption may be assumed at about 8 lbs. of coal an hour. But the consumption of fuel enables the open fire to perform other functions besides those of warming. It is a great engine of ventilation. One pound of coal may be assumed to require, for its perfect combustion, 160 cubic feet of atmospheric air; 8 lbs. would require 1280 cubic feet; but at a very low computation of the velocity of the gases in an ordinary chimney-flue, the air would pass up the chimney at a rate of from 4 to 6 feet per second, or from 14,000 to 20,000 cubic feet per hour; with the chimneys in ordinary use, a velocity of from 10 to 15 feet per second often prevails, giving an out-flow of air of from 35,000 to 40,000 cubic feet per hour.

We have therefore to consider the open fire in two aspects:—

1. As a method of warming.
2. As an engine of ventilation.

In its aspect of warming, the radiant heat from the fire does not warm the air of the room; the rays from the fire warm the sides, the back and parts adjacent to the grate, they warm the walls, floor, ceiling and the furniture of the room, and these impart heat to the air. The form and material of the fire-place can thus assist materially the warming of the air. The rays should impinge more freely on the walls and floor than on the ceiling. A projecting chimney-piece, with a surface favourable to the absorption and emission of heat, would be more favourable to the warming and circulation of the air than one which would allow the rays to pass to the ceiling. In an ordinary fire-place the sides should be splayed, as in the Rumford form of grate; the sides and back should be of non-conducting material, with a surface favourable to the rapid absorption and emission of heat. Thus brick or tiles are better than iron for this purpose. Similarly, the degree to which the materials of the walls or floor of the room are unfavourable to conduction, but favourable to the absorption and emission of heat will have a bearing on the capacity of the room for warmth. The open fire, moreover, has this advantage, that a person can obtain just as much or as little heat as he desires by placing himself in front of the fire or at the side.

There is, however, this inconvenience about the open fire. The large volume of air drawn out of a room by the chimney must be supplied from somewhere, and consequently the very means adopted to heat the room tends to produce draughts, because the stronger the direct radiation, or rather the brighter the flame in open fire-places, the stronger must be the draught of the fire and the abstraction of heat.

Let us next consider what are the conditions which we require for comfort. The normal temperature of the human body is 98° Fahr. If it rises much above or falls much below that, death would ensue. But the human body is a furnace in which the process of combustion is continually

going on. Therefore, in order to preserve the normal temperature, the body must continually give off a certain amount of heat. By the laws of radiation, a heated body parts with its heat more or less rapidly in proportion to the low or high temperature of bodies near it. Thus, if a hot body be placed near a cold body, the hot body will radiate heat rapidly. If the hot body be near a body less hot than itself, but still hot, it will part with its temperature slowly.

Let us apply this to a room. If you are sitting in a room near a cold brick wall you feel what you think is a draught. It is not necessarily a draught at all. But the side of your warm body turned next the wall parts with its heat rapidly, and you experience a local chill. If you hang a piece of carpet against the wall, the draught is no longer felt, because the carpet checks the rapidity of the radiation.

Now the chief source of heat in the open fire is its radiant heat, and as it warms the walls of the room and the furniture, it takes off any sensation of chill from the walls, &c., although the air may be comparatively cool.

You must next bear in mind that the proportion of radiant heat to the total heat given out by a heated body depends on the temperature of the body. Thus, with a red-hot piece of iron, or a flame, the great part of the heat given out is radiant heat; whereas with a body heated to from 150 to 200 degrees, like a hot-water pipe, a comparatively small proportion is radiant heat. Therefore, when you heat a room by means of hot-water pipes or by means of warmed air, the walls do not get warmed in the same proportion, and although the air may feel warm, the walls may remain cold, so that the heat of the body may be radiated to the walls and give the sensation of chill.

I confess that personally I think there is nothing to be compared with what my friend Sir F. Bramwell calls the pleasant pokeable fire. But I do feel most strongly that, however much private feelings may incline us all to use the open fire, it is our duty, now that our towns are becoming so vast, to adopt some method of heating which will produce less smoke. It is not as if there was any

probable and early limit to the size of London or of other large towns. They grow continuously, and London has progressed at the same steady rate since the beginning of this century. In 1851 it contained a little over 2,000,000 inhabitants, and was looked upon as vast and abnormal. It now contains 4,000,000, and is steadily increasing. The smoke destroys our light, it injures our air, it ruins our furniture, our pictures, our decorations, and with the increase of London this must go on in an accelerating ratio. But it requires education in the people to get rid of it. The Smoke Abatement Society, under the chairmanship of Mr. Ernest Hart, was the first organized attempt to overcome this gigantic evil. In response to the demand then made many new forms of fireplace were proposed, but the practical conclusion to be derived from that Exhibition was that so long as we burn our fuel in the raw state in our rooms and in our kitchens we cannot get rid of smoke.

The main object of the present Exhibition is to educate the people in the science of health. The public has long felt the want of pure water, and has obtained a supply of comparatively pure water in the metropolis. The public has not yet become fully alive to the necessity of pure air. It is our business at this Exhibition to endeavour to awaken the public mind to this want. So far as purity of air depends on removal of refuse from our midst, there is hope that in that respect this object may be attained. Although no doubt even this simple question is much neglected. Dust is generally removed in open baskets, and emptied into open carts, in a manner which seems to have been designed for the purpose of scattering it as much as possible into the surrounding atmosphere; but the purity of air which depends upon the absence of smoke is another matter, and I fear that it will be many years before the selfishness of the community will give way on this question.

The first point to consider is, if we dispense with the use of the open fire, how can we obtain that comfort which the open fireplace gives? The comfort of the open fire is due

to the warmth it imparts to the floor, the walls, and the furniture.

The air of the room is warmed not by the rays from the fire but by the warmth imparted by those rays to those various objects. Therefore the air of the room is somewhat cooler than the walls. Now there is undoubtedly greater exhilaration produced by breathing cool air than by breathing warm air. This is readily accounted for. One cubic foot of cold air at 32° Fahrenheit contains 113 grains of oxygen, whereas one cubic foot of expanded warmer air at 60° Fahrenheit contains only 84 grains of oxygen. It is desirable that air admitted to a room should not exceed from 55° to 60° temperature for comfort in breathing.

This will at once explain to you why the employment of warmed air alone to warm your houses does not give comfort. If the warmed air is admitted at a comfortable temperature for breathing, viz., about 55°, the walls, which derive their heat from the air, will be somewhat below that temperature, and discomfort is caused by the warm body radiating its heat too rapidly to the colder walls. Therefore if you are to abandon the open fire, but retain its comfort, you must warm the walls and floors, &c., of your rooms. If you can maintain your walls, floors, and ceilings a a temperature of from 55° to 60°, combined with an adequate change of air, you will not experience much inconvenience from the loss of the open fire, however much you may regret its companionship and its pokeableness.

There are four ways in which we may effect this. In three of these ways one fire in each house in a central position would be used. In the fourth the heat would be applied in the room itself by means of gas. It is probable, however, that a combined arrangement would be desirable.

In all the cases where the heat is furnished from one fire, this fire would be in a close furnace for warming each house or self-contained block of buildings; and thus the fire could be so arranged by means of self-feeding apparatus to be practically smokeless. The heat from the fire would

be conveyed to the various parts of the building by hot air, hot water, or steam.

Where warmed air is used, it would be necessary to adapt the house in its original construction to the purpose, because the air would have to flow up through spaces in the walls from the basement. Moreover, it would not be economical to bring up the air in the outside walls, because then nearly half the heat would pass direct to the outer air. The warmed air passing up the central walls of the house would part with some of its heat to the walls, and would thus enter the room at a lower temperature than that of the walls. In order to draw up the warm air into the rooms, it would be necessary to have some means of extracting the air from the room, so as to draw in the warmed air. It would not always flow in of itself in this country.

Thus you see that the warming by means of fresh air involves ventilation, and moreover requires, if it is to be thoroughly efficient, that your architect should have thought out the whole problem when he first plans the house, and before you build it; otherwise you are met with difficulties at every turn.

In the method of heating by hot air alone, you have this further consideration. The air in the heating chamber is necessarily at a given temperature, and your house is thus heated uniformly; but it may happen, in this climate especially, that you may want one room to be warm whilst another is cool. It is generally on this account that other methods of heating have been preferred. It is to these methods of heating that I would now direct your attention.

These methods are hot water pipes or steam pipes, led from the fire, which is placed in some central position, and arranged to accumulate the heat in those rooms or other places which it is desired to heat. I will at once say that the arrangements hitherto made of warming by either hot water pipes or steam pipes, have not fulfilled the conditions I have mentioned as being necessary to supply the comfort

of the open fire. The method adopted is to accumulate a certain amount of heating surface in a coil, or nest of pipes, or in what is termed a radiator in the United States, but no plan of distributing the heat by means of a large flat surface placed close to the wall, has been generally adopted. I do not wish to imply that it has not been thought of, because some few years ago in an Exhibition of sanitary appliances held at the Society of Arts, Mr. Pritchett, of Bishop's Stortford, suggested something of the sort.

The apparatus he suggested consists of a series of receptacles, or cases, for water. The cases themselves were formed of ordinary plates of corrugated metal, strongly put together, but having a small interval between them, so as to unroll the water, as it were, into a film, and form a succession of reservoirs of water, about thirty inches in height, more or less, as is required, but only from half-an-inch to one inch in thickness; enabling them, therefore, to be placed continuously, as a dado, or as a series of panels, round any room or building intended to be warmed, and occupying scarcely any appreciable portion of the space of the room or building.

The corrugated form given to these reservoirs not only increases the area of the external surfaces, back and front, and imparts strength to the vessels, but secures a certain amount of friction in the action of the warmed water within the vessels, which predisposes it to part with its heat during its circulation. I have never seen these reservoirs applied in practice on a large scale. The panels might conveniently form the dado of a room, and, if of six feet high, would ensure the comfort of the occupants of the room, as they would effectually prevent persons in the room from radiating the heat from their persons to the surrounding walls. Such panels all round the room would especially lend themselves to warming fresh air to be admitted into the room. Mr. Pritchett proposed that these should be warmed by the circulation of hot water; but it is certain that it would be more advantageous to employ steam to heat them if they were established on a largc scale.

In England steam is not much employed for heating. We are prejudiced against it. We fear accidents. It is, however, a method of conveying heat which is eminently suited to use on a large scale: and if we are to hope to abolish our smoke nuisance, it is by methods of heating on a large scale only that we may hope to succeed. Steam heating is extremely simple in its application. Steam is easily led to great distances. Steam-heated pipes are hotter than hot-water pipes, therefore their effect in warming the air in contact with them is also greater; and, therefore, when heating is required on a large scale, it will be found that it is more economical to use steam-pipes than hot-water pipes; besides which, the pipes may be smaller, and thus in both ways expense is saved. Highly-heated steam-pipes, moreover, radiate a large portion of their heat to the walls and furniture of a room.

Heating by steam is universal in the United States, and the usual system may be described as follows:—The steam is conveyed from the basement along pipes to the room or passage where it is wanted to be used, and there it is passed into a cluster or coil of pipes called a radiator, which gives an enlarged heating surface. The cause producing the circulation throughout the pipes of the warming apparatus is solely the difference of pressure, which results from the more or less rapid condensation of the steam in contact with the radiating surfaces; a partial vacuum of greater or less amount is thereby formed within the radiating portions of the apparatus; and the column of steam or of water equivalent to this diminution of pressure constitutes the effective head producing the flow of steam from the boiler; while the return current of condensed water is determined by the downward inclination of the pipes for the return course. Therefore the flow-pipe should be carried in as direct a line as possible from the boiler to the highest point; all the coils for heating should be placed on the return pipe, which should be laid in a uniformly descending line back to the boiler, so arranged as to prevent the lodgment of any condensed water on its way there; because, if

condensed water lodges in the pipes, most unpleasant and startling noises result.

It is a source of economy in steam-heating that the condensed water should flow back to the boiler. This is what is called closed circulation, with separate supply and return mains, both of which extend to the furthest distance to which the heat has to be distributed.

It is, however, possible to carry the steam and bring back the condensed water by means of a single main, which answers at once for both the supply and the return, either with or without a longitudinal partition inside it for separating the outward current of steam supply from the return current of condensed water. If more convenient, the return of the condensed water to the boilers may be dispensed with, and the steam may be applied in what is called the system of *open circulation*, where a supply main conveys the steam to the radiating surfaces, whence a return main conducts the condensed water either into an open tank for feeding the boiler, or into a drain to run to waste, or for use as hot water, the boiler being then fed from some other source; in either case suitable steam traps have to be provided on the return main for preserving the steam pressure within the supply main and radiators.

The difficulty of steam-heating lies in regulating the temperature of the pipes. With hot water you can have your pipes heated to anything you like from 50° to 100°, but with steam pipes it is different. The heat is got up very rapidly when the steam is turned on, and goes off very rapidly when turned off.

There are various arrangements for regulating steam-heating when applied to warm inflowing air. In the New York Hospital the incoming air is warmed by coils of steam-pipes, and generally to a considerable temperature; but in order to prevent the warmed air entering the wards at too high a temperature, this hot air is passed into a mixing chamber, to which cold air can be admitted at will, so that the hot air can be mixed with cold air to the extent necessary to moderate its temperature before it is allowed to flow into the wards.

There is, however, one great advantage possessed by coils of steam-heated pipes. They give out a larger proportion of radiant heat to the walls than is given out by hot-water pipes. You can easily understand how much simpler it would be to warm Mr. Pritchett's dados and wall panelling by steam-pipes carried through them instead of by hot water.

The next way in which heat can be applied is by means of gas. A gas jet warms any surface in contact with it. If, therefore, you enclose a gas jet in a metal case, and if you bring air to feed the gas-burner from the outer air, and carry away the products of combustion also to the outer air, you can use the heat of the metal case to warm the surrounding air in the room, whilst the fumes of combustion from the gas will be taken outside, and do no harm to the air of the room. Gas jets might thus be applied with the greatest ease to warm Mr. Pritchett's dados and wall panels, the gas jets being placed inside the dado, and the products of combustion carried to the outer air.

Mr. Boyle has invented a very efficient method of applying gas to warm inflowing air at an ordinary ventilator. It is in use at the Guildhall. The fresh air inlet has placed in it a pipe which is coiled round. A gas burner is placed at the bottom of the pipe, separate from the air of the room; the products of combustion pass up the coiled pipe and then down and out to the open air, the pipe being warmed by the heat they give out in their passage, and the fresh inflowing air being warmed by the pipe.

Of course in all these arrangements air must be extracted by flues or fans or some other method, so as to ensure a due circulation of air.

But however advantageous gas may be in the methods of its application to warming—and I do not hesitate to say that it can be easily applied so as to be hygienically perfect in that respect; and moreover, you can apply your heat at the exact point at which you want it; you can so arrange it as to give out a low degree of heat for warming fresh inflowing air, or to give out heat to warm your dados and prevent your own body losing its natural heat too rapidly

by radiation ; or you can use it to give out a high degree of heat, and thus to furnish radiant heat to warm you by direct radiation ; it has only to be carefully adjusted to produce all these advantages—yet there is this enormous drawback to its use : At the price of 3*s.* 6*d.* a 1000 cubic feet it would cost, to effect these things, fully four times the price of coal.

I believe that if it could be supplied so as not to exceed double the price of coal it might be economical to use it, because you can apply it when and where you desire it ; you can turn it off when you leave your room, and turn it on again when you return ; and in this climate, where our changes of temperature in winter are so rapid, a uniform heat applied everywhere often becomes oppressive.

Let us consider for a few minutes what is the meaning of revolutionising the methods of warming our houses in the way I now propose. We should not load our atmosphere with soot. Each of the fires in a house requires its separate chimney ; and as if the householder were determined to do all in his power to make the atmosphere impure, the smoke which is arrested in the chimney flue in the form of soot is periodically pushed up out at the top of the chimney into the air, not only to the detriment of the occupier of the house, but to that of the neighbours—an arrangement which may be witnessed any morning in houses where chimneys are being swept. These inconveniences result from having separate fires in every house, and for each separate object.

Let us consider for a moment the amount of labour and expense entailed by the mere supply of fuel upon this separate system. Take, as an example, one house of moderate size. The consumption of coal at a low calculation will be 24 tons a year, which would require 12 carts to convey it to the houses, or a street such as Eaton Place, would require 1,200 carts to supply it with coal. These carts entail the presence of between 2,000 and 3,000 horses, and each horse causes, by the manure it deposits in the street, an additional pollution of our atmosphere. When

the coal is placed in the house, these 24 tons require to be carried up in coal-scuttles, each holding probably a quarter of a hundredweight. That is to say that there would have to be carried from the cellar to various parts of the house nearly 2,000 coal-scuttles full of coal. The residue would have to be carried down again in the shape of ashes, probably to the extent of 400 coal-scuttles, independently of the proportion of ashes which get scattered from the fireplace about the room, and have to be cleaned up by the housemaid.

In addition to this, the dirt engendered by the smoke and soot sent up into the atmosphere, renders much additional cleaning necessary, and entails on the inhabitants of London a vast expenditure on soap, and on repainting and redecorating our rooms. Indeed, a lady artist who used to be celebrated for her skill and taste as a decorator of houses, told me she had no sympathy with the movement for the abatement of smoke, because she looked upon smoke and fog as specially sent by Providence for the benefit of decorators. But you must recollect that all the labour mentioned above is wasted force. It entails vast unnecessary labour and waste of fuel. Probably, if the price of coal had remained as high as it was in 1875–6, we should ere now have begun to warm our houses in a more rational way.

But it is not on the ground of economy that I advocate a change. It is on the ground of purity of air. So long as we pollute the air with soot, not only is the outside air impure, but the air is so loaded with dirt that the careful householder excludes it from his rooms where possible. You would all be ashamed to supply your guests at a party with bad water. If you were equally ashamed—which you ought to be—to supply them with bad air, we should soon take measures to build our houses so as to keep up a continual flow of fresh air throughout our rooms. And then we should be rapidly compelled to take measures also for warming our houses in a way which would not pollute our atmosphere.

The CHAIRMAN thought that the lucid manner in which Captain Douglas Galton had explained the necessities of the household, and the difficulties in the way of overcoming the evil, and the manner in which science must be brought to bear upon the subject, had rendered clear many problems which had been hitherto obscure. He feared the evil of which so many complaints were made was one of such enormous extent that no method was likely to be introduced for some time which would bring about a general amelioration. Any such remedy would, no doubt, come from heating by hot water rather than by gas. Many experiments had been made in this system of heating, but they had been by no means successful, as it had been found that the radiating power was too small, and the products of gas could not be kept out of the apartments. In some instances explosions had occurred. Though it might be difficult to apply the methods which had been suggested, he thought no one would regret having expended an hour in listening to the able lecture. He begged to propose a cordial vote of thanks to Captain Douglas Galton.

The resolution passed unanimously.

Upon the proposal of Mr. WHEELER, a vote of thanks was accorded to the Chairman for presiding.

HEALTHY FURNITURE.

BY

ROBERT W. EDIS, F.S.A.

VOL. III.—H. L.

JULY 7TH, 1884.

REPORT OF A SPEECH ON HEALTHY FURNITURE.

By ROBERT W. EDIS, F.S.A.

Dr. ERNEST HART in the chair.

The CHAIRMAN said one of the objects of the promoters of that Exhibition was to study health not only in its drier and more scientific aspects—health as understood by the doctor or chemist or philanthropist, who was aiming at some great public object, but besides taking in those larger questions of health treated from their highest and most abstract standpoint, the aim was also to take in everything which could touch the healthy life of the home; for although the Health Exhibition was the main title, its sub-titles were the habitation, dress and technical education. In order that health should be studied most fruitfully it should be studied in its practical applications to all that concerned the surroundings of our daily life, and Mr. Edis was a gentleman who had given special attention to the combination of art with health in the decoration of our homes. There were many people who, in going through the Exhibition and noticing some of the very pretty houses and decorations might say, What had they to do with health? but that would be a question which Mr. Edis would answer. To ask what chairs and tables, walls, carpets, and hangings had to do with health was really to

ask whether we should live without any healthy intentions or without any consideration for health in our customary surroundings. That question had been put to him very often by people who evidently thought they were saying something very clever, but he took it the presence of the audience that evening would signify that they agreed that the objects in a domestic house, elements of domestic decoration, ought to be at least very largely governed by considerations of health, and that so far from its being irrelevant to consider what tables and chairs, and hangings, and the surface of walls and floors had to do with health, it was really necessary to consider how all that was most beautiful in a house, and all that was most reasonable and economical might be made to ally itself at once to health, and to beauty. The subject was very fertile in suggestions, and no one could be more competent to treat it than the gentleman who had so kindly consented to speak on the present occasion.

Mr. EDIS said: It has been my lot for some time past in this Exhibition to sit upon a jury, which has had the making of various awards for various exhibits, in which it was supposed that art and health were more or less practically allied, and I am bound to say, that I have heard with a great deal of astonishment the great difference of opinion that has existed amongst my colleagues, as to the question of how far health and art are or can be allied in any shape or manner. I can, therefore, assure you that it is with the utmost possible diffidence that I come before you, this afternoon, to give a brief address on those points which I think should be practically considered in the decoration and furniture of every house in which health has to be practically considered. Because, although health to a great number of people may merely mean pure water, good drainage, and pure air, I take it there are many points in the rooms of a house in which the air we breathe is as much influenced for the worse by things that are placed in the room as it is by impure smells.

On all matters in which the association of artistic design with healthy construction and decoration is considered, I shall speak with the greatest possible diffidence, because artistic taste is so diverse, that it would be hardly possible, even in an assembly like this, to get you all to agree with me on mere questions of taste. Still I hope that on some points in which taste and artistic design are to be considered from a health point of view, that I shall find a certain number of listeners who will be in accord with the views that I may express. It has often struck me that there are people in this world in whom the sense of sight is altogether uncultivated. They see all kinds of pretty things; and in their annual holidays and excursions to foreign countries see magnificent scenery, pretty buildings, pictures and other works of art, which they greet with the remarks of "How fine!" "How beautiful!" "How grand!" showing to a certain extent that they have a love for the picturesque, and a certain appreciation for that which is beautiful either in nature or art; they are willing to give to the God above us, who has made those things beautiful about us, and to the art-workers in the world, who have made the art we have to look at in any shape or way, the credit they deserve; but in a certain manner it seems to me the sense of sight in ordinary matters is almost entirely uncultivated. I do not suppose there is anyone in this room who willingly or knowingly would eat uncooked or badly cooked food, or smell bad smells without making a fuss about it; or anybody who would listen to a hurdy-gurdy in the street and not drive it away, under the powers of the Act of Parliament which permit us to drive discordant music away from our doors, but yet the sense of sight in many people is as much lost sight of, as if it did not exist. We are still content to have in our houses the most unartistic and ill-drawn designs in papers, the most inharmonious arrangements in pattern and colour in our carpets, and furniture, which are not only unartistic and bad in general design, but oft-times comparatively useless and unhealthy in construction. We are still willing to admit all this bad art

into our rooms, and, therefore, I say to a great extent the cultivation of the sense of sight with many of us has been neglected.

Now let me turn generally to the question of whether there is any truth at all in the statement, that certain illnesses are brought about by impure air. If it is true that impure air, and rooms made impure by dust and dirt, bring about all kinds of ailments that are objectionable in life; if they give us those minor diseases to which we do not know how to give a name; if they help to engender lassitude or ennui, which prevent us carrying on properly our work in the world; I think you will agree with me that it is desirable, as far as may be, to make our rooms as healthy as possible, by casting out everything which tends to make them foul and unhealthy, and that the houses we live in should be made as cleanly and as wholesome as possible, not only from a mere personal point of view, but to my mind also, from the general sanitarian point of view as regards the whole community, because you may fairly look at questions of sanitation, as the financier does at questions of finance. "If you take care of the pence, the pounds will take care of themselves;" and in the same way the sanitarian says, "If you take care of the houses, the towns will take care of themselves." I am quite sure, having reference to a land not far away from us, where a terrible and disastrous epidemic is bringing death in its most ghastly form to numerous communities, that if the sanitation of each individual house in the various towns in which the cholera is now raging had been properly looked to, the general state of the towns and village would have been more fitted to cast out the evil which is now in their midst, than it is at the present moment.

As far as the coverings of the walls of our rooms are concerned, from my point of view, little or no thought has been shown in the artistic design of these until quite recently; designs which, in their spottiness and inharmonious arrangement and colouring, imperceptibly affect our nervous system, have been made more unhealthy by the use of

arsenic in their colouring. We have been content to cover the whole floor surface of our rooms with thick carpets, to take them up perhaps once or twice a year, and thus allowing to remain for months an accumulation of dirt and filth, under and in them, perfectly ghastly, and I need not say terribly unhealthy; if the dust and filth that accumulates under these floor coverings are allowed to remain for weeks and months, I take it that a certain stuffiness and foulness must be engendered in the room, and a certain amount of danger to our health, which may not be quite so serious as bad drainage or impure water, but which in point of fact exercises upon our general health a considerable amount of influence. We have been content to hang our windows with venetian blinds, on which, day by day, and week by week, the dust clings, and which is rarely cleaned off, and when it is occasionally brushed off by a careful servant in the morning, it simply rests somewhere else in the room, and if dust and dirt really tend to disease in any shape or manner, I take it that all those resting places for dirt and dust should be got rid of.

Take for instance the ordinary furniture of a bedroom in which we live all the worst portion practically of our lives; I say this advisedly, because although rest takes place at night, we shut the doors and windows, and we breathe over and over again the air that is in the room, and if you will go into any room in the morning, that has been shut up closely for the six or seven hours of the night, you will find the air absolutely unwholesome, the room impregnated with a deleterious atmosphere, which practically means, that for the last hours of our sleep, we have been breathing absolutely impure air, and hence often when we wake, we feel unrefreshed and unwell. I want, as far as possible, to see our rooms fitted up so that these evils of dust and impure air may be minimised, for it is quite hopeless to suppose that they will be altogether done away with. I dare say there are many here who will say that these minor questions are not worth considering, that they have drained their houses properly, that they have their cisterns cleaned out,

and that they have pure water, and what else do you want? I am anxious to impress upon you that it is necessary to make every house as healthy and clean inside as you possibly can do, and if you want to do this, you must have more regard and care for the internal decoration and internal fitting of it. It is not enough to see that the drainage is properly done, it is not enough that you see your cisterns properly cleaned out, and that the water is pure.

The house cannot be said to be absolutely healthy, until the decoration, furnishing, fitting, and ventilation of the rooms are taken up in a proper sanitary manner, looking at it from the common sense, and not merely from the æsthetic point of view. For bear in mind that I have nothing in common with those schools of so-called æsthetes, who demand that you should have a certain type of furniture, or a certain type of paper, which may or not be a good one; but I will not trench, as far as I can avoid it, on this not unknown, but not debatable ground in a meeting of this kind. I have nothing in common with those who advocate any particular system of decoration or furniture.

Not very long ago it was considered quite the right thing, if you wanted to paper a drawing-room, to hang it with an imitation moiré silk white paper, on which was scattered all over bunches of gold flowers, tied up in the most impracticable and unnatural manner. While the bed-rooms were hung with papers in which conventionalised primroses or other flowers were tied together in bunches, geometrically arranged, on some staring green or other vivid coloured ground; the spottiness and pronounced patterns had a most ghastly effect, if fevered and brain tired you lay awake in the half light of early morning, adding to your sleeplessness, and, therefore, want of healthy sleep. It is perfectly useless to say this does not affect us; if we pretend to have any sense of sight or cultivated taste, and if all these unartistic and spotty patterns are ghastly to you when in good health, how terrible must they be

to those who are suffering from sickness or nervous unrest.

Therefore from a health point of view, this question of paper hangings does materially form an element of good or bad health in our rooms. I am not going into the question of artistic design or artistic merit. I want to avoid trenching on that ground as much as I possibly can, and therefore I do not propose to say very much upon what kind of paper you should choose, but I do say avoid those patterns in which these bunches of flowers or fruit are tied up with ribbon, or in which you see cherubs conventionalised into extraordinary attitudes, tied together with strings of roses, for cherubs never were tied together with them in their lives, as far as we have any reason to believe. You want those cherubs to get out of the way; or you see them with their mouths wide open, and you want them to shut them. You may have a pattern in which birds are open beaked catching at flies, which they never do catch. All this frozen life worries and annoys you; your nerves are materially affected by these bad decorative forms, which are so common in many of the patterns of our wall hangings; and if the æsthetic movement is responsible for any of these things, I say the sooner it is done away with the better. We want things natural and good for the benefit of all humanity; we do not want things that may be said to be peculiar, or eccentric, or different from anything else. In the bedrooms you should have papers of no particular pattern, on which you can see no unnatural groups of birds, animals, or flowers frozen into stiff forms, which in any way conduce to unrest and worry to nerves or mind, and thus to want of health. I would suggest that in all bedrooms it is desirable that the paper should be of some all-over pattern, which presents no special marked forms of any kind, and which diffuses itself into one broad tone of colour, so that you are pleasantly influenced, rather than the reverse by what you see on the walls.

I am not going to enter very much into the question of arsenical papers, because I think that most good manu-

facturers of papers now altogether avoid that extremely deleterious drug, and that anybody who purchases wall papers from any good house may be perfectly certain that they will not have any arsenic mixed up in the colouring. All I would wish you to understand, and probably a good many of you do, is, that arsenic was originally used not only as a colouring matter in what are called apple-green papers, but also largely in all the pretty browns, French grays, reds and some of the purple grounds of papers. I know one firm that used several tons of arsenic per month in the making of their papers, which, I am glad to say, now no longer allow arsenic to be brought on their premises. Therefore as far as wall papers are concerned, I think you may be perfectly certain that all danger as regards arsenical colouring has been done away with. I would avoid, as far as possible, covering the walls of your rooms with flock papers which have a raised pattern, made in a great degree of powdered wool, which is stuffy and clinging in its nature, and so collects and holds dust and absorbs all kinds of impurities, which to a certain extent exist in every room of a house in which there is no perfect or systematic ventilation ; and even if it be painted, the raised pattern holds dust and possibly, therefore, germ seeds of disease, for which reason it must be manifestly unhealthy not to say dangerous, to have on your walls any kind of flock paper with all its strongly raised and absorbing surface patterns, in which infection and impurities of all kinds can be absorbed.

No amount of washing with carbolic acid and water or repainting would do away with the seeds of disease infection, which would be still left in the paper, and might be dangerous to those who lived afterwards in the room. Beyond all this question of danger through these dust and germ seeds left about the room, there is a large amount of stuffiness which is engendered by anything which is clinging in its nature, anything in which foul air can be absorbed. I have already spoken of the room being shut up at night. Every woollen curtain, everything in the way of drapery hanging in the room, absorbs every day and every night, a

certain amount of impurities, which are thus left in the room and cause a certain amount of stuffiness, and unhealthiness which no amount of window opening will ever get rid of. I therefore hold that in an ordinary bedroom, all kind of hangings are not only perfectly useless, but dangerous to the healthiness of the room. I do not see what you want with them at all, if you have a good dark shade of blue tammy blind that will keep out the light. All you want is not to have the light interrupt your sleep or wake you when you are sleeping, and so far I hold that, from a healthy point of view, all hanging of any kind whatever should be avoided in the ordinary bed-rooms of a house. There is one other matter about wall coverings which people who are doing up their houses ought to take especial note of, and that is the question of bad paste. We sometimes go into new houses, or into an old house, which has been newly done up, and discover a faint unpleasant sort of odour, and do not know what it is and cannot discover the cause; perhaps if you are nervous or fearful at all, you call in some expert, thinking there are rats under the floor, or that the drains are bad, and have them opened. But this sickly smell often arises entirely from the bad size in a state of putrefaction. If you ever smell it, let me advise you to insist on the paper being cleaned off and the whole walls being redone. It is all very well to say you can mix the size with salicylic acid, so as to take away the bad smell, but you cannot get rid of the offensiveness. which will cling for many months in the room, without re-doing the whole of it.

As regards the fitting up of our houses, we are accustomed to buy our furniture ready made. I suppose very few persons present buy ready made clothes; although no doubt ready made clothes get a certain amount of custom, but, I take it, that people who want to be decently fitted, go to their own tailors, or milliners and dressmakers, and have their clothes fitted for them, and made for the particular season for which they are required, Now with regard to furniture it is nothing of the kind.

The whole of it is generally bought ready made. You go into a shop and buy a wardrobe, a chest of drawers, wash-stand, of course a bed, and a lot of other small things, which you put about the room, and there you are; you have bought ready made furniture, and whether it fits or is suitable, or useful, or not, does not make any difference. You take it on trust and put it into the room. Sometimes you get a thing that does suit, but generally a thing that does not suit. Chests of drawers are made certain shapes and sizes, and you cannot get all your clothes into them. They do not hold enough, or they hold too much. If you want a piece of clothing in the summer time, you often have to hunt it up out of the whole drawer, and probably have to turn out a good deal of winter clothing with it. Now I want to see a little more thought in the furnishing of our rooms. If you take the wardrobes and that kind of furniture, which is seven or eight feet high, as a rule, you cannot see the top of it, but on this top there is generally a sunken space three or four inches deep left by the cabinet-maker, who simply leaves it, because it is not seen, but in all these spaces dirt and dust must collect, because in every house there must be a certain amount of dust and dirt even with the most cleanly arrangements, and the most cleanly set of people. These spaces are not cleaned out every day, it is impossible. No servant can get up to them without standing on a pair of steps, or a high chair, and she does not do it, as a matter-of-fact. It is all very well to say, Oh, my house is sweet and clean, the servant dusts them; the servant does not do it, she will not get up on a chair and clean them every day, and if she does clean them every day—if you have careful and good servants, and I daresay there are some, though a great many are not—they only sweep away the dust, where? Not out of the room, but on to something else down below; and there it lies, and gets under the carpet, or into the crevices of the floor. The only effect is that it is disturbed for the purpose of making your room more stuffy and more unhealthy. The only way of getting rid of the dirt is by cleaning it out

with a damp cloth. I should like to know how many people in this room can say their servants do that periodically. If they do, my lecture and my advice is of course perfectly useless on this point. Instead of having a chest of drawers, a wardrobe, writing table, and washstand, and all these kinds of things quite separate, and with small spaces underneath, in which all kinds of dirt and filth and fluff accumulate, which you cannot get at without you go down on your hands and knees,—which servants cannot always, or generally do not do—if you have that kind of furniture you cannot get rid of the dust and dirt and unwholesomeness in the room. Why not take a portion of the room and fit it all up together, knowing what you want to put into it. It is all very well to say that some cupboards go up to the ceiling, and are a great deal too high. But I take it, we wear certain clothes in summer and certain clothes in winter, and it would be quite as well to stow away your winter clothes on the top in the summer, and the summer clothing on the top cupboards in the winter time; and I think most ladies will agree with me that those cupboards might be made exceedingly valuable as store cupboards, for putting away things which were not in use, only taking care occasionally to see that they are all right, and to put a little camphor amongst them, until the time comes when you want to change those things which are in the lower portion to the upper. In some such fitting as this you can concentrate into one end of the room all the furniture you want. You may make a wardrobe, a wash-stand, a dressing table, and a bookcase, all at one end of the room if you please. I do not want to allude to any particular exhibit in this Exhibition; but there is one exhibit which practically carries out my advice, in which this arrangement is shown, and if you will take the trouble to look at it you will see by example much more than I can teach by any number of words, and you will be able to judge whether it is worth looking at at all from a health point of view, from which alone I am speaking.

Again, our houses in London, unless we are very well off, are not very large, and if we have a large family, which we some of us have, some consideration must be shown to the younger members. It is all very well while they are young and babies, to put them into one room which we call the day nursery, and let them have their play in the daytime, and stow them away in little cots side by side in the night nursery, in a way that is quite charming when they are under the supervision of one especial person, the nurse. But when those children grow up, they want something more than that. I take it that no father or mother wants to have a number of children always about them, nor do the children always want to have the father and mother with them. Therefore, each bedroom, I think, in every house should be fitted up as far as practicable so as to make it a sitting-room for those who are growing up, so that every child should have more or less his own sitting-room in his own bedroom. This system obtains to some extent in French rooms; where they have also a most charming arrangement, whereby a sort of little room is partitioned off as a small washing closet, wherein bath and towel horse and things of that kind are put; this closet is formed at one end of the room, and the bed is drawn across; so that practically the washing closet is opened up by drawing a small curtain in the morning when it is wanted to be used. It seems to me in a great measure that this French system has many advantages which we might well copy. But whether we do that or not, a system of fitting up the room so that you may hide the bed; put the bed practically in one corner, and be able to draw a curtain around it in the daytime—and the curtain should go right up—so that there should be no resting place for the dust, would be much more pleasant to everybody who has a family to bring up.

This brings me to another question, the floor covering of the room. Floors are often entirely covered with carpet or matting. I advise in the bedroom of a house, that the whole surface of the floor should be painted or stained; varnish is better than anything else probably, except

parquet, which is very expensive, or marble which is more expensive; and perhaps that might be considered too cold to the feet; at all events take care that every crevice in the floor is filled up, and then paint it with three or four coats of brown colour, any shade you like, so long as you leave no ledges or no holes and crevices into which the dust and dirt may get, because if you do that, you will be frustrating the very object of painting the room; and the whole should be varnished with two coats of good varnish. You have then a floor which can be easily swept over with a damp mop or a damp cloth, and the whole of it may be kept clean with little or no trouble. And upon the floor next to the bed, or next to the washstand or writing table, may be laid rugs, which are quite sufficient for all purposes. Before passing from this subject, let me say that all woodwork which is painted should be varnished, as varnish is practically non-absorbent, is easily cleaned, and adds much to the healthiness of the house.

There are so many other things about which I could speak if time permitted; let us take the ordinary coal box. As a rule these are very ugly things, which are moved about here and there, and of course the dust is spilt about the room, and when it is left open, it is not a very pleasant sight to look at. Why cannot we put in one of the cupboards an ordinary swing bunker, hidden away when not required, and pulled out with a swivel hinge. In that way an objectionable feature of the room is done away with, and you have what is necessary in every house in London, and it is easily accessible.

It would be impossible to have a healthy room practically without having good ventilation. About a fortnight or three weeks ago, it was my lot to have to come up from the Eastern Counties by a train which arrived in London about half past three in the morning; and as I drove from the East End to my own house, about three or four miles, I looked up at every house, passing along through the lower stratum of London, to see what sort of atmosphere the people who were living in the rooms were then enjoying. I found

with the exception of perhaps one or two per cent. every house, in a hot pleasant summer morning, a most lovely morning it was, was hermetically sealed. Every window was closely fastened up; God knows how many people were in the rooms, probably five or six is a great many, and I thought as I passed along through the fresh air of London, how can these people be healthy, who are living in rooms in which they shut themselves up in this way on a summer's morning?

With regard to the question of ventilation, it is not necessary to sit or live in a draught. There can be no fear of catching cold if the room is ventilated in an ordinary common sense way. But in an old house, or in a new house, if there be no scientific means of extracting the air; and I believe, speaking as an architect, it is exceedingly difficult to get this except by motive power, or heat, there may yet be provided means for the ingress of fresh air, and for the egress of foul, and if you have a sufficient amount of fresh air continually brought in, even if you do not get an outlet for the foul air, the room is certainly kept pure and sweet, because the heat in the room is an active pumping power drawing in to a certain extent fresh air, out of the street. The best and simplest way of bringing in fresh air is by means of angle tubes in the rooms communicating, through the outside walls, with the outside air, these tubes having proper regulating valves and gauze screens or sponges to filter the air from blacks and other impurities; these tubes can be put up at a cost, including cutting away of the wall, of £1 or 25*s.* a piece, and I hold that no room in London or of any town should be without one or more of these tubes. They can always be regulated, if the cold air outside is so intense that the amount of air brought in makes the room too cold, by an ordinary butterfly valve; and the air kept free of dust and blacks by some such system as I have named, namely, a wet sponge or rag placed at the mouth of the air-tube, so that the impurities of the outside air can be practically screened before it passes into the room.

Before I conclude, let me make one appeal with regard to the nurseries. The ordinary system is to consider the nurseries, because they are at the top of the house, as of no importance, and that it does not matter how they are furnished or decorated; but in my opinion, whatever you do, these rooms, as they must be the first teaching of the sense of sight to every child that has to live in them, should be fitted up with the most loving and skilful thought, else it is not worth having them at all. You may make the nurseries sow first of all in the child's mind, seeds of truth in art, or you may make them teach them to be careless about truth and art, or make them unhealthy in all kinds of ways. I do appeal for our little ones, that every nursery should be made as good as it possibly can be by a proper treatment of the walls and floor surfaces. By making the furniture as convenient and useful as it possibly can be, placing around our little ones pretty things to look at, and thus gladdening the sense of sight as much as we possibly can, so that in after life that sense of sight, which is thus early cultivated, may bring forth good fruit.

I can only thank you now for listening to what I am afraid you have considered a somewhat dry subject. I have done the best I could, in the short space of time allotted to me, to give you some few notions about furniture and decoration. I feel how little I have said. But I do ask you to consider more carefully the decoration and furniture of your houses, so that not only you should bring greater health to your children, and to yourselves, but that you may, by having good art around you, bring into every house the grace and preciousness of beauty and refinement.

The CHAIRMAN then proposed a vote of thanks to the Lecturer, which was carried unanimously.

THE DOMESTIC USE OF GAS.

BY

HAROLD B. DIXON, M.A.

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JULY 9TH, 1884.

A LECTURE ON THE DOMESTIC USE OF GAS.

By HAROLD B. DIXON, M.A.

IN venturing to speak to you from a scientific point of view on the domestic use of gas, I hope I may not appear to be approaching a subject of such vital importance to our homes with a light heart, and to be rushing into mysteries where even the initiated speak with fear and trembling; but when I am told for the five hundredth time that the gas is bad, because the gas-flame flickers or roars, and you get blacks on the ceiling; when I find the housemaid for the thousandth time putting the poker against the bars "to draw the fire," as she calls it; when I find paterfamilias saying he will have his joint roasted with an honest English fire, and will have none of your new-fangled gas-arrangements; I think it is time to speak out. The gas-flame does not roar and blacken the ceiling because the gas is bad, it does so because the gas-burner is unsuitable. The poker does not draw the fire—but I will not enter into that, for I do not want to run my head against a popular fallacy, which does not enter into my subject; but I can assure paterfamilias that he would not know whether his joint were roasted by an honest coal-fire or by a gas-flame, but in the latter case I know he would pronounce the joint to be exceptionally juicy.

Now when I say I shall speak of the domestic use of gas

from a scientific point of view, I mean that we must start from the commencement, and see what kind of thing coal gas is, and what is the nature of its combustion. Now, coal-gas is a mixture of bodies, but it contains chiefly hydrogen, and bodies called hydro-carbons; they are gases made up of hydrogen and carbon. Coal gas is quite invisible, transparent and colourless; when it burns, the hydrogen burns to water; it forms water by combining with one of the constituents of the atmosphere, and the carbon in the same way-forms carbonic acid, and those are the only two products formed when the coal-gas is properly burnt. So that what you have supplied to your house is a mixture of hydrogen and hydro-carbons; when you light the gas, they burn and produce steam and carbonic acid. But they do more than this, because hydrogen burns more readily than carbon, so that if you have a stream of this coal-gas, of hydrogen and hydro-carbons, coming out into the atmosphere and lighted, the hydrogen burns the faster, and some of the carbon gets left behind unburnt; of course it gets burnt in time, but before it can reach the outer air and be there burnt to carbonic acid, it passes an intermediate stage, when it is in the solid state of little aggregates of carbon, and they are intensely heated and give out light; they finally reach the air outside the flame, and then they burn to carbonic acid. You have to look very steadily at the side of the flame to see the fine film of non-luminous flame surrounding the non-luminous gas-flame, but if you do that, you will see that for about one-eighth of an inch all round the luminous flame you have an outer coating, and there you have the carbon being burnt to carbonic acid.

Now there are several ways in which coal-gas may be burnt. Suppose you mix coal-gas with 10 times its quantity of air, and apply a light to it, the whole thing will burn almost directly, and we have what is called an explosion. The air being previously mixed with the gas, each part of it is in close contact with the air requisite to burn it, and you have a flame propagated through it with great velocity, and if it is in a closed vessel you have a report. You have hardly any

light, but you have intense heat developed, and the noise which we call an explosion. That is one extreme. Unfortunately we are familiar enough with the fact that coal-gas and air mixed together will explode. Coal-gas by itself of course cannot explode, because it has not the air required to burn it.

The flame itself is due to a chemical combination; the particles of coal-gas, that is, the hydrogen and hydro-carbons I have been speaking of, come into collision with particles of the air, those particles we call oxygen, and grappling together with intense energy, they give out light and heat from the force of the shock. I do not propose in more detail to go into the theory of flames, but merely to say that you must have chemical combination, and you must have a combination taking place between gases at a high temperature. Whenever you have that, there you have flame. I told you just now that you may have a sudden flame passing rapidly through a great mass of coal-gas and air mixed together, and have an explosion, or you may have the coal-gas supplied through, and pouring out of a pipe, but then it does not mix with air all at once. It meets with the air at the edge of the flame, so that you have coal-gas inside and air outside, and at their union, where they come together, you have this chemical combination, and you have a flame. In this gas-flame you have hydrogen burning to steam, and carbon to carbonic acid. Of course they are quite invisible, but the steam and carbonic acid are pouring away into the air. In the flame there is a considerable area of illuminating surface. That is produced by the solid particles of carbon inside the hydrogen flame heated up to whiteness, not being able to burn, because there is no air there to burn them. It is only when they get to the outside that each little particle burns. But this burner is so arranged that air can be passed to the inside of the flame. At the bottom of the burner there is a hole, so that I can let air in, and as the coal-gas runs up the pipe, it creates a draught at the bottom, and pulls in the air, and you will immediately see the character of the flame is altered. This is a flame in

which we have no separation of carbon, and the flame is much smaller. These flames are commonly called Bunsen flames, from Professor Bunsen of Heidelberg, who first introduced this kind of burner. Here we are making the mixture of coal-gas and air at the bottom of the burner; you get no light from it, but just as much heat as before. There is a common fallacy, and even makers of gas apparatus are not quite certain on this point, that this flame gives out more heat than the other flame. That is not so. It gives out exactly the same amount of heat; whenever you are burning a given quantity of gas you get a certain quantity of heat, no more and no less; but this flame is hotter because it is much smaller. You have the same amount of heat in a less space, so that a Bunsen flame is hotter than a luminous carbon flame. Secondly, you do not get any soot from a flame like this. I can hold a plate in this flame, it does not tarnish at all, there is no soot deposited on it as there would be in an ordinary flame. I will now make the flame luminous, and you see the soot is immediately deposited. That of course is a proof that you have here solid carbon particles inside the flame. I could not show you a better proof of the existence of solid carbon than putting a cold plate into that flame and letting the carbon particles be deposited upon it. With a Bunsen flame drawing in air at the bottom you have none of those carbon particles.

Now I will go a step further, I do not mean to the extreme step of having an explosion, but I will drive air into the burners. I have here a pair of bellows connected with the burner by a tube, and I will now drive the air into the middle of the flame. The same quantity of gas is being burnt, but the flame is still smaller; the combustion is more perfect, and I get it into so small a space that you can hardly see the flame at all. Of course the amount of heat is the same in all these cases, but you have a very much higher temperature, that is to say, the heat in the very small flame is concentrated. I hold a little bit of asbestos just above the flame, and you see what a high temperature we reach, sufficient to heat this asbestos up to whiteness—

to a very much higher temperature than we can get in an ordinary flame, which hardly heats it to redness.

I have said that a coal-gas flame is giving out steam and carbonic acid, and I want to show you what kind of things these two products of combustion are. You do not see any steam coming away from this flame, but there is really steam pouring up into the atmosphere and we can easily catch it. I have here a flask of cold water. I will hold this in the flame, and it will condense the steam outside. The cold water inside will keep the glass cool, and the flame playing upon it will deposit steam. Those who are near it can see that it is covered over with dew, and if I held it longer you would have fair-sized drops of water. Of course if I held it long enough I should raise it to the boiling-point, and then the water would be again dissipated. A word or two about the other product of combustion, the carbonic acid, which is poured out into the atmosphere and remains there as a gas. I will make a little carbonic acid, and show you its properties. I put a little chalk into this glass jar, and pour a little water on it, then I add a little acid, and we get an effervescence; the vessel is now filled with gas, which will no longer support a flame. This is carbonic acid, the same gas as we get out of a gas flame. This gas is heavy, so that I can pour it from one jar to another. Of course you do not see it pass, but it has filled the other jar, as is evident by the fact that it extinguishes flame in the same way. Now I will test this gas, and the usual test to apply to it is lime-water. First I put a little ordinary water into the jar and shake it up. Nothing happens—the water keeps perfectly pure. Now if I put a little lime-water to it and shake it up, you see it becomes milky at once. That is one of the ordinary chemical tests for carbonic acid, that lime-water becomes milky with it. You see here some of the properties of this carbonic acid; it is very heavy, so that I can pour it like a liquid from one vessel to another; it will not support combustion, and it turns lime-water milky. I will now take an ordinary jar, which is of course filled with air, and

hold it inverted over a small gas-flame in order to catch some of the products of combustion by making the gas burn inside the vessel. You see the flame very soon loses its light; it uses up the air inside the jar. Now I will take the jar away and test it in the same way with lime-water. We immediately get the milky appearance due to the absorption by lime-water of the carbonic acid produced by burning the carbon of the flame. You see then the coal-gas is of this nature, it is made of hydrogen and hydro-carbons, and it burns to steam and carbonic acid when completely burnt.

But if we want to get light from it we must not completely burn it directly. We must burn it with what may be termed a selective combustion. We must let the hydrogen burn first, and then let the carbon burn afterwards. You must not get the gas mixed up together with the air or you will get a bad light. You must burn first the hydrogen and then the carbon. In that way the carbon gets heated up by the heat of the burning hydrogen, and as long as you can keep it heated up and unburnt it gives out light. Now let me use an illustration to bring home to you what I mean by a selective combustion. Suppose at a school-treat there were 50 boys and 50 girls, and I had 50 oranges, and I wanted the boys to get all the oranges. I might put them all in a line, and put the oranges in another line 100 yards off, and supposing the boys ran faster than the girls, then the boys would get all the oranges, and no girls would get any. But if we put all the boys and girls together and threw the oranges among them, and let them scramble for them, then even supposing the boys to run twice as fast as the girls, the boys would not get all the oranges. The boys would get two-thirds and the girls one-third. Now it is the same thing with the coal-gas flame. If you let the hydrogen and carbon scramble promiscuously, as it were, for the oxygen of the air, though the hydrogen will get more, still the carbon will get some; whereas if you make them start from a given mark equally, the hydrogen will always get first at the oxygen, and the carbon will always have to pass through a lonely period without the

oxygen with which it wants to go off. We must arrange then a method of burning in which the hydrogen shall always be allowed to burn first.

Now let me tell you shortly what I consider to be the chief requisites of a good gas-burner; for there are a dozen bad gas-burners to one good one. You want first of all that the temperature should be very high. We have seen that the light comes from the carbon heated up to a great intensity, and the hotter you can make the carbon the better the light, so that the first requisite is a high temperature of the flame. To obtain this, the top of the burner must be of a non-conducting substance; a metal top conducts away some of the heat, and so lowers the temperature of the flame. The best burners have steatite tops. The second is that you should have a very steady and slow flow of the gas into the air, otherwise you will have the gas and air mixing, and you will have the hydrogen and carbon scrambling for the air, and not racing for it regularly, as I pointed out just now. So that the second requisite of a good burner is that the flow of gas should be very slow. You must remember that the pressure in the mains is generally some inch or so of water, that is to say, very much larger than you want at the burner itself; so usually there is some arrangement just below the orifice of the burner where the gas comes out, by which the pressure is checked. The gas is sometimes made to flow through a small hole much smaller than the hole above, and then comes into an enlarged chamber, from which it flows slowly through the burner top into the air. In other burners you have what is called a governor put into the pipe below the burner. A governor is generally arranged with a movable steatite piece inside, which is pushed up by the flow of gas against it, and so partially blocks a little orifice where the gas comes out. If the pressure is increased, this movable piece is pushed further up, and consequently the hole above is made smaller, so that although the gas is under greater pressure, the hole being made smaller, you get the same quantity of gas coming out. The holes, of course, are

adjusted, to give the same quantities of gas with different pressures.

To illustrate these remarks, I will show you a pair of gas-burners so arranged that the pressure of gas can be very much altered. I have here a bag, by pressing upon which I can increase the pressure above that supplied in this building, and show you the effect of a high pressure. Here are two burners, one an ordinary burner and the other with a governor, and I have the means of altering the pressure on the gas. When I increase the pressure you hear the very familiar hissing sound heard in so many houses; the light diminishes, and if I increase the pressure still more, we get hardly any light at all. Now the other burner will show the effect of the governor in stopping this excessive pressure. Both burners are supplied by the same pipe, and I put exactly the same pressure on both. In one the pressure is checked by a little governor, and in the other one it is not; and you notice the difference. We are all familiar with the fact that the pressure of the gas varies. When the pressure is turned on in the mains in the evening, we have to turn down the gas, but with a governor like this the gas is as good with a high pressure as with a low, because it is stopped from flowing too quickly.

Thirdly, you want a steady flow of air to the flame. One of the most important sources of annoyance with coal-gas is the fact that they make the globes, which surround the ordinary bat's-wing and fish-tail burners, with an opening at the bottom very much too narrow. In nine-tenths of the houses you go into, if you look at the globes you see them like this one with an opening at the bottom one inch, two inches, or two and a half inches across, whereas it ought to be three inches or three and a half. If you have a small opening you have a strong current, and an irregular swirl of air rushing up, and the gas-flame continually throbs and flickers. It is almost impossible to get a steady flame with such an apparatus; so that the third requisite is a steady flow of air to the gas-burner. Let me draw your

attention for a moment to this ordinary burner with a narrow mouth globe upon it. You are all familiar with a gas-flame of this kind, it is never steady for half a second; and to most people who read by gas-light, I think, it is this continual flickering which is the annoyance. It is not because the currents of air in the room are not steady, but the flame continues to jump in this way merely because the orifice is so constructed, that the air rushes in rapidly, gets into a swirl, and throws the flame about. Now I will show you by the side of it a similar burner surrounded by a globe with a larger orifice. You will not see that continual flickering of the flame which you noticed with the other one. The difference is due to the different sized opening at the bottom of the globe.

I pass on now to a different kind of burner, the argand. This argand is made in a different way from the flat flame burner we have considered. Here we have the extra trouble of having a chimney, which has to be cleaned, and occasionally replaced when broken. The burner is ring-shaped, the ring being pierced by a number of small holes, so that you have a number of little jets of flame which join and form a hollow cylinder, and the air comes to them both from the inside and outside. The air passes up the middle of the burner to the gas inside, and supplies the inside of the flame, and more air goes outside, where a metallic reflector deflects it on to the flame, so that you have a race for the oxygen on both sides of the flame. You have a ring which is burning both outside and inside. Of course a chimney is requisite to keep up the draught, and throw the air with sufficient force against the flame. In this way you get a more brilliant light than with flat-flame burners; and until lately this was the best form of burner you could have for burning ordinary coal-gas. But, lately the flat-flame burners have been so very much improved, that I doubt whether it is now to one's advantage to get an argand burner, for the increased price of the burner, and the fact that you have greater trouble in cleaning and expense in replacing the chimney, is hardly made up for by the

little increase of light you get over the best flat-flame burner.

Now a great improvement has taken place lately with regard to the formation of very brilliant flames. We see now in our streets whole groups of flames put near to one another, and each of them very considerably increased in brightness, owing to the heat derived from those in its neighbourhood. You remember that the first requisite we set out with, in considering what goes to make a good burner, was high temperature. Now, if you have two flames burning alongside each other they give considerably more light than you would get from the same two flames separately. The fact that they are close together prevents the loss of heat by radiation, for the heat which one of them radiates is partially caught by the other. We not only have two flames brought together, but three, and even more joined in the same way, each of them helping the others by radiating out heat to them, and so making the carbon of each flame hotter than it otherwise would be. There is always an advantage in having flames close together, if you supply the air properly to them, because each flame then is hotter, and the carbon is heated up to a degree of greater incandescence.

There are many other kinds of burners, the details of which I have not now time to go into. Perhaps I may say the burner of the future will be a burner in which the heated products of combustion are not allowed to escape into the air, as they are in most gas-burners of the present day. We, as a rule, do not want the heat from the burner, and should be glad to get rid of it. Now if you heat the air supply which goes to burn the gas, you will get increased illumination. In regenerative burners, which I think are the burners of the future, you have the heated products of combustion, carbonic acid and steam, which rise or are drawn down through metal chambers, making them very hot. The air supply which burns the gas comes to the flame through pipes in these chambers, so that the air itself gets very hot before it reaches the flame. In this way you

have an economy, the products of combustion pass away fairly cool, and the air which comes to the flame comes to it very hot, so that the heat of combustion is added on to the heat already acquired, and you have a very much greater intensity of heat in the flame. Such a burner was brought to some perfection by Mr. Siemens. Large burners of this kind are now being manufactured for lighting large spaces. We had a display of them, I remember, some time ago in Holborn. I do not know whether they are being shown now in the London streets. A modification of this Siemens' burner has been introduced, and promises to be all that can be desired for a domestic burner. I have not yet seen them in private dwellings, so that I will not say more about them, except that I think some form of the regenerative burner will be the burner of the future.

I will now pass on to the second part of my subject, and that is the use of coal-gas for heating and cooking. We have seen that coal-gas may burn in two different ways; it may give light by the separation of carbon, or it may give a non-luminous blue flame without any separation of carbon at all. Now if we want to heat any vessel, the quickest and cleanest way is not to have a luminous flame, but to have a non-luminous flame. Here is an apparatus to show how gas may be used for getting a supply of hot water. At the bottom of this apparatus is a ring gas-burner; at the top is a supply of cold water. The water falls into a sieve, passes through it in a fine spray, and then falls on to a plate beneath, which is perforated with holes, through which it falls on to a lower plate, and so on. The plates are arranged alternately, so that the heated gases pass by the edge of one plate and through the centre of another. The gas at the bottom is burning to steam and carbonic acid, which rise up through this series of plates and finally escape at the top so cool that you would hardly tell by the hand there was any gas burning beneath. All the heat of the products of combustion is absorbed by the water tumbling through the apparatus. It takes a minute or two to get warmed up, and then we find the water flowing

away at the bottom quite hot enough for an ordinary bath. Now in any system of cooking or heating by gas I should propose to do away altogether with the boiler. I think the kitchen boiler is one of the great nuisances of domestic life. It needs periodical cleaning, because our water is hard, that is to say, it has a lot of calcium carbonate, and calcium sulphate, and magnesium sulphate dissolved in it, and from these matters you have a deposit or fur accumulating on the surface of the boiler. When the inside becomes coated with fur, it is a source of danger. When a coating of this non-conducting material forms inside, the iron outside may be heated up to redness by the fire; then if a bit of this crust breaks off, the water comes into contact with the red-hot iron, there is a sudden evolution of steam, and a bursting of the boiler, or the pipes for supplying the water, or carrying it off, get choked up with this fur. Steam is generated and finds no escape; eventually it overcomes the strength of the boiler and bursts it. Now, in a system of gas-heating, such as I think will sometime supersede the ordinary kitchen-range, you will not have a boiler at all, but you will have a therma, or water-heater, where you want it; one upstairs for heating water for the bath, and one below in the scullery for washing-up plates. If you want to boil a kettle you will do it on a gas-burner, such as that at the top of this gas-stove. This stove itself is a gas-oven, with a grilling arrangement and kettle boiler at the top. I daresay many of the audience are quite familiar with the appearance of a gas oven. There are two rows of burners at the bottom. The gas is drawing in air and burning with a blue non-luminous flame. It is so perfectly burnt that there is absolutely no smell. There are shelves in the oven, and also a movable iron plate. You light up the gas, turn it on full by a tap at the side, and in about ten minutes the oven is hot. You then put in your leg of mutton, and in an hour-and-a-half to two hours it is done. You do not require to look at it after the first twenty minutes, when you should turn the gas down a little, because when once the iron is hot it will keep at the right temper-

ature with a less supply of gas. At the bottom is a dish into which the dripping falls. A very considerable advantage in this arrangement over the ordinary roasting before a fire is this, that the juices do not come out of the meat, the joint is heavier when it comes to table, and I think it is nicer to eat. At the top of the oven there is an iron plate which is used for browning. If you want to cook a fruit tart you put it in near the bottom, and bake it in the ordinary way, but without browning the crust. You then take it out, about a quarter of an hour before you want it, and put it in near the top. This iron plate is just an inch above the top of the tart, and in a short time it is beautifully browned all over, which is, I believe, what you want in pie-crust. Above the oven you have a burner which is reversible, and is used either for boiling, or for toasting and grilling. It is now toasting a piece of bread. When this burner is turned up one way, the flame is at the top ; when it is turned over, the flame is underneath. It has a rim of iron all round it, which gets almost red hot and radiates heat downwards on the chop or whatever you wish to grill. There is no difficulty about it at all. A busy bachelor like myself can cook his chop without any trouble, and while this is going on, can have his kettle hot, ready to boil directly the burner is turned over.

One word about braising meat. I may be wrong, but I understand that in braising meat it is very important that you should not boil it : you have your large braising saucepan, you put the meat and vegetables in with a little layer of water, not enough to cover the meat, and then keep it, as cooks say, just simmering, that is to say, just not boiling, and leave it so a considerable time, and in that way it gets beautifuily browned all over. With a gas stove you can do this to perfection. You need never watch it ; you turn up the gas so as just to have it simmering, not boiling, and as long as you leave it there, and do not move it, it will keep just at that temperature. The steam from the boiler is condensed by the lid, and flows back again, so that you have no loss of water, no trouble

of looking at it, and you keep it at the right temperature as long as you please.

Just one word about a bit of apparatus which I think is very ingenious, which has been lately invented to use with an ordinary oven. In the summer months one often does not want to have a kitchen fire alight, and would be glad to be able to cook meat with a gas stove, but might not want to go to the expense of putting in one. This little apparatus, I think, you will find of great use, for with it you can turn an ordinary oven into a gas stove. It is arranged with a clamp, by which you fix it on to the oven-door. The little clamp just serves to keep the door of the oven open the right amount; for in this cooking by gas you want an air supply. It differs from baking in an ordinary oven, where you shut the oven door, and do not have an air supply. In a gas-oven you roast the meat, but do not bake it, and you have an air supply coming in at the bottom, and of course going out at the top. By this arrangement you turn an ordinary oven into a gas-oven, and this clamp, as I have said, just keeps the door open sufficiently for the air to come in to roast the meat. I think if any one wishes to try what gas cooking is, and I certainly recommend it during this hot weather, they can get one of these put into an ordinary oven, and see how they like it, and if they like it they can get a gas stove.

I have one other experiment, to show how gas may be used to give us a pleasant little fire without the use of coal or coke at all. Here is a little asbestos stove: it has a row of small non-luminous Bunsen flames at the bottom which play in front of a fire-brick, and between the interstices of the fire brick there are put little plugs of asbestos. The flames of the Bunsen burners, which are of a very high temperature, although they do not give out much light, pass over the asbestos, and raise it up to bright redness; with this little stove one can toast very readily, or boil a kettle, and I think it presents a very agreeable appearance. I have one of these in a small study at Oxford. I have not a

fire-place, but I have bored a little hole in the wall to carry off the products of combustion, and the stove acts perfectly well.

Those are all the experiments I propose showing you, but I have a word or two to say on the subject of smoke and fog. A method has been proposed to you which I am persuaded is a very good one, of using a gas-kitchener and a therma for heating water. By this plan we do away with the very serious annoyance of the smoke which London houses are continually pouring out into the atmosphere. We do not get a particle of smoke from any of these apparatus. I take it that all we want in our fires is that they should have a pleasant appearance, warming the house by radiation—not by hot air poured into the room, which I think is objectionable. This asbestos fire does not do that, it gives you radiant heat and no smoke at all. There is no chimney attached to it, yet I defy any one to see any smoke or products of combustion coming from it. Of course there are carbonic acid and steam. The therma gives no visible products of combination; in the same way with the kitchen-stove, the oven, griller and boiler. All these things are standing on the table without a chimney of any kind, but yet there is no smoke. Even if one quarter of the houses of London did this, what a very great difference it would make in the smoke hanging over us, and in the smoky fog which arises from it! We cannot stop the fog, of course, for it is condensed aqueous vapour. We have as much fog in the English Channel as we have in London, but in the Channel it is a clean white fog; it wets you a little, but when it blows off you are none the worse; but in London the fog passing over our houses gets mixed up with this carbon smoke and other stuff which comes out of our coal-fires, and on each little water-particle there is a layer not only of this carbon, but of sulphuric acid, and other choking compounds. It is these which make the London fog so utterly deleterious and objectionable, that I think nothing can be worse. If we had such burners as these, if we had our meat cooked and water boiled by gas

stoves instead of by coal, we should get rid of the smoke which goes to make the worst part of the fog. I do not say we should do away with fog altogether, for that seems impossible with our present knowledge, but we should do away with the most unpleasant part of it, the part which is not only unpleasant, but exceedingly dangerous to health.

HEALTH IN THE WORKSHOP.

BY

J. B. LAKEMAN,

H.M. SENIOR METROPOLITAN INSPECTOR OF FACTORIES.

JULY 31ST, 1884.

A LECTURE ON HEALTH IN THE WORKSHOP.

By J. B. LAKEMAN,

H. M. Senior Metropolitan Inspector of Factories.

IT will be admitted that there can be no more interesting subject for consideration, than the well-being of the toiling masses of this kingdom who are daily administering to our wants, to our comforts, and to our luxuries.

Evidences of sympathy have been abundantly given whenever a calamity has overtaken our operatives, and even solicitude and tenderness have been extended to them from the Queen of England down to the lowest of Her Majesty's subjects.

The variety of their industries, the severity of their toil, the dangers incident thereto, combine to evoke our keenest interest, and to elicit our regard for their welfare.

It seems to me that the subject of "Health in the Workshop" is equally important, and deserves the consideration of every employer of labour, so that the law which enforces sanitation in our factories and workshops may be generally accepted as salutary and economic.

The Conferences and lectures which have been held and delivered here by eminent men, the exhibits which are displayed throughout this building, even the very intentions of the promoters of this grand scheme, have had each and

all for their bases, the word "*Health.*" Health for the dweller in his domicile, health for the eater and drinker in that which he consumes, health for the pleasure seeker in what he requires, health and ease for the invalid in whatever adds to his comforts or would conduce to his convalescence; everything around us here, and all that has been said, mean progress towards so great an end, and suggest to the multitudes who visit here, that if they chose, they can see what has been set before them, whereby the blessings of health may be enjoyed as far as human skill and knowledge can be exercised therefor.

But seeing that such great things have been set before us, one might ask to whom have they been addressed, or to what end have they been collected?

Do such magnificent appliances and able lectures influence the rich and poor alike, or are these displays accepted only by those who can afford to indulge in the luxuries of life, and to whom, to will is to accomplish, or to desire, is to satisfy; in other words, is this Exhibition to be a universal school whose teachings will have a general application, whose aspirers after knowledge to be gained here, will put into practice in their several engagements of life, the lessons taught, so that those who hold the responsible position of employers of labour, may enhance the well-being and comfort of their helpers in toil by taking heed to the many sanitary improvements exhibited here, so that when the closing time will have come, it shall not be said that this undertaking was only intended to be an agreeable place of resort, where the senses and tastes were roused to a plethora of gratification, but *rather* that no efforts have been wanting to secure permanent results for good as the outcome of the Exhibition of 1884.

I hope truly that for the sake of eleven millions of workers in this kingdom, who are or ought to be protected as to their lives and health in their several occupations, that many employers of labour have closely studied whatever there is here calculated to do their people good,

and *have* taken advantage of the valuable lectures given, and the novel designs exhibited, so that in the future, labour in factories and workshops shall be conducted only under conditions favourable to "Health."

It has fallen to my lot, as a layman, and as a complement to the Handbook I have had the honour to write, to address you on the subject of "Health in the Workshop," which I shall strive to do, plainly and truthfully, by citing only what I know from experience; I shall not attempt to advance a scientific opinion of my own, nor pretend to deliver a scientific lecture, but I shall endeavour by the aid of a long official life to show you what has been done, what is being done, and what remains to be done before health in the workshop can be said to be fairly established.

Permit me to observe that an employer of labour is a person of greater importance than I fear is generally considered. He employs (1) for his own ends, purely and directly; (2) for the increase of a production for general good, indirectly, for if he gets paid for what he produces, he cares not where his goods go; (3) he *should* so employ for the benefit of his hands whose well-being is involved in the due consideration of the close relationship that ought to exist between them. There is Health in the workshop in this—and in proportion to his uprightness in mode of manufacturing, in his calling things by their right names, and in his employing under principles of equity, so will he exert a very great influence by such morality on economic success. Here also is Health in the workshop—And to myself, who have seen so many phases of the labour question and the uprisings of discontent amongst workers, it is a matter of great sorrow that our characteristic energy, enterprise, and independence of spirit, which are so essential to productive industry, should lose aught of their full development by a break in the chain of co-operation between master and servant of absolute fairness and conscientiousness, and with that impression I proceed to my subject by asking you, if it be either fair or conscientious to employ persons for the employer's direct benefit under conditions

that tend to debilitate and ultimately to undermine the health, for I am persuaded that no more weighty cause, whether social or economic can be found, than are the moral conditions between masters and men, and which either elevate or degrade the spirit and the heart; and herein too lies a secret of Health in the workshop, for unless virtue in its strictest and true meaning, be practised by employers and employed, decline and failure on one side or the other, or perhaps on both, will be the certain consequences of indirectness.

I could not refrain from making these remarks, being so devoted to the principle of fairness in all things.

I propose now to deal with the question how factories and workshops can be made more healthy, what dangers workers are exposed to, and how little regard is paid to sanitation or ventilation.

I will trespass on your time by referring to domestic workshops and their affinity to dwellings which are so neglected, I shall also refer to the Law as now existing and to the advantages, if any, which would accrue from more definite enactments. I shall also by the aid of diagrams specially prepared show you how ventilation may be cheaply secured—(*a*) in a factory using motive power, where conditions as to structure are favourable; (*b*) where three sides of the factory are shut in, as is the case with most occupations in London; (*c*) in workshops, where no motive power is used, and wherein passive appliances only can be set up.

VENTILATION.

It has been said, that however productive of greatness the industry of a nation may be, such greatness, if it be at the cost of the lives of its producers, is not real, or worthy of admiration, but quite the reverse, and should provoke shame.

This is a bold assertion, and perhaps it might be sustained if, from a total disregard of Nature's Laws, the lives of our operatives were placed in peril.

It cannot however be denied that as a nation we are very

backward by comparison, in sanitative education, and that the laws of ventilation are sadly neglected by our employers of labour—indeed such knowledge has not formed part and parcel of our schools' programmes to prosecute, and on that account I think much of what is complained of can be accounted for. It is true that in many large factories a great improvement in sanitation has been seen, and if we trace out who and what the occupiers thereof were or are, we should find that they have had the control of very extensive works, and were endowed with the philanthropic spirit of desiring to do as they would be done by, and moreover these men have found that by the application of sanitative law, their work has been better done, a larger quantity has been turned off by more uniform attendance, and the quality of work very superior.

It is to be noticed that although our factory laws date back to 1802, we knew not what sanitative restriction meant until 1864, when six certain trades which were said to be injurious to health were included in the factory code, and again in 1867, when another wide extension of the law was made, the same clauses were inserted, but it was not until 1878, that textile factories, although subject to the law since 1802, were brought under these said clauses—we cannot therefore be very much surprised that in this respect the value of Factory legislation has not been as fully appreciated as have been other portions of the Act, and which *plainly* set forth things required and forbidden.

To enumerate the various trades which are injurious to health when unaided by proper ventilation would include metallic dust-producing occupations, mineral dust, vegetable dust, and animal dust.

In the first, needle-makers, file-makers, grinders and moulders suffer in lung diseases to the extent of 50 per cent.; in the second, flint cutters rank highest, even up to 80 per cent., grindstone makers 40 per cent. The third shows that cigar makers suffer to the extent of 36 per cent., although in this trade I know full well that there is a great variety of occupations from the cleanest to the most

neglected. Weavers suffer to the extent of 25 per cent., whilst it is seemingly strange that chimney-sweeps, charcoal-burners and coal miners suffer the least, the last not at all, simply because carbon acts as a preservative. The fourth includes brush makers, 49 per cent., from the swallowing of bristle ends and dust; button makers 15 per cent., chiefly where swift machinery is used in turning horn, bone, or vegetable ivory; hat makers are quoted as suffering to the extent of 15 per cent.—no doubt the process includes the manufacturing of inferior felt hats, which are made of a variety of waste products other than felt—but where no dust is generated, nor motive power used, but owing to a want of ventilation, hundreds of industries are carried on to the injury to health of many thousands of operatives, to the extent of 18 to 20 per cent.

It is said that the fibre of cotton is the most hurtful of all vegetable dust, and produces diseases of throat and lungs, and according to the evidence given before the Commission in 1876, the *death* rate from chest affections in Flax Mills is 31 per 1000.

In cotton weaving sheds, owing to want of effective ventilation, I have seen the hair and face and clothes of weavers covered with pulverized china clay with which the warps are sized. Sizing is a process preparatory to the weaving, for the purpose of stiffening the warp so that the weaving may be done the better, without it cloth could not be woven, but during a certain epoch in the history of the cotton trade, about twenty years ago—men learned the art of weighting the warps with this china clay, so that a fictitious weight of cotton might be accepted, for you must know that Manchester folks do not buy by length but by weight. So extensively was this practice indulged in by many little weavers, that cloth for exportation has been found on arrival in India to have been a decomposed mass of vegetable and mineral pulp. Special enquiries have been made into this; from which great results were expected, but I think I am correct in saying that to day ventilation in many cotton-weaving sheds is imperfect.

In silk mills, where the utmost cleanliness is observed, filaments of silk are given off, and in woollen mills, the sorters, that is, those men who first handle the wool, before it is washed, suffer terribly from minute insects called "bacteroids," each about the $\frac{1}{9000}$th part of an inch wide; so prolific are they said to be, that it is computed that one of these tiny mischief-makers will produce 16,800,000 others in 24 hours.

What I am anxious to show is, that in textile factories, ventilation can be successfully set up to carry off dust and other impurities, and in very many cases is—that cubic space per worker often exceeds 3000 feet, and where proper appliances are not set up, the evil to be overcome is visible. In the trades under Act of 1864, viz.—Fustian cutting, lucifer-match making, earthenware, including potteries and brick making, paper staining, percussion-cap making, the want of ventilation and cleanliness were apparent, and occupiers were sensible of the value of the Law as then introduced, and I am bold to say, that the results in a few years were beyond all expectation. In the potteries of Staffordshire, an habitually high rate of mortality prevailed, paralysis and other nervous diseases were to be seen in all their aggravated forms, lung diseases rose to 7·85 per 1000 fatal (males) and 6·17 females—physical and moral degeneration, and the potter's consumption were strongly marked as evidences of the want of salutary restriction. In lucifer-match making, necrosis, or jaw-bone caries prevailed, from the inhalation of phosphorus, and if any of you had ever seen a confirmed case of "flute" or "compo," as workers called the disease, you would never forget it, most painful, loathsome, hideous, and offensive. All this is changed; superior modes of manufacturing were commenced and successfully continued, sanitation and ventilation were primary considerations; slavery and cruelty to the young were absolutely forbidden, and our children of toil and bondage were freed in like manner as were those engaged in textile productions between 1802 and 1844. But when we proceed to the Act of 1867 when the humanising

influences of the Law were to be introduced to the Black country, to the midland counties, and to every other centre of industry including London, we have to include numberless industries totally dissimilar, carried on with and without motive power, and which, though not of themselves injurious to health, are made so for want of sanitation and ventilation. Generally speaking, we find great improvement in trades wherein visible effects of injury to health were found; and in which, when appealed to, masters were forced to acknowledge that certain appliances would effect much good; to these places the remedy was applied, but we suffer most in such places as printing-offices, book-binding factories, clothing, baking, artificial-flower making, fancy-box making, glass-blowing, bleaching, dyeing, &c., tobacco and cigar making, india-rubber and gutta-percha manufacturing, brass foundries, and places for the conversion of metals; because in them, no visible effects can be traced to employment, but where insanitation and want of ventilation abound.

I am anxious to impress on you the great necessity there is to provide free air for workers, lest, by persevering in the same way in which we are now proceeding in our *miscellaneous* trades in large towns, our operatives, especially females, may deteriorate through want of vitalised blood.

The object of ventilation is, to keep an inhabited room in as pure a state as possible, and to assimilate the air therein as near as can be to the external air, or to keep it so pure as not to be injurious to health. This can only be done by supplying fresh air in proportion to the impurity to be removed, it is therefore evident to us that ventilation must have much to do with respiration, for if by inspiring foul air we impair the action of our lungs and poison them, pure air must be breathed for the maintenance of health. Let us think over this and try to apply it, putting it syllogistically. Blood requires purification, pure air vitalises the blood, therefore to live, we must breath pure air. Food gives animal power by the conversion of chyle into blood which by the heart is sent right through our bodies; the vitality,

of the blood determines the quality and quantity of work done by it, if blood be deteriorated, the functions of the body show a like depreciation.

The renewal of waste to the blood is effected in two ways—by the formation of fresh chyle, and respiration. What does respiration do? It enables exhausted and powerless blood, which has done its work to *absorb* oxygen from the *inhaled* air, and it frees carbonic acid, which is driven out by exhalation, and this carbonic acid is the worn-out production of the organic work of the blood, so that we have a wonderfully adjusted system at work, alternately feeding with purity and expelling impurity.

Therefore the blood is the direct producer and supporter of life, and the *quality* of the *blood* determines the *character* of the *life*, is it not evident then, that if pure air be denied to us, our vitality becomes weakened, and death will ensue.

If a healthy person can breathe pure air, his animal temperature is higher than one who is not so favoured, and if such a person be employed in any manufacturing process, he can work to advantage and regain his animal loss, and *vice versâ*.

Now if a number of persons are found at work in a room where ventilation is not carried out, the exhaled air becomes rarefied, it will rise to the ceiling, and having no outlet, the stratum nearest the ceiling becoming cooled, descends, is diffused, and *contaminates* whatever *free air* may *be beneath*, and when we know that carbonic acid is a great absorber of heat, and radiates in proportion to its power of absorption, it will descend by reason of its superior weight, and *still more pollute* the breathing air. This carbonic acid is bound to be present in the purest atmosphere, for it forms in a most minute degree one of the constituents of air, but if its presence exceed 6 volumes in 10,000, then danger to health will follow. Thus, a man exhales $\frac{6}{10}$ of a cubic foot of carbonic acid per hour, that is, he is poisoning the circumambient air to that extent, therefore in five hours he exhales three cubic feet of carbonic acid, and in order to keep the quantity of carbonic acid down to the 6 volumes

per 10,000 not less than 15,000 cubic feet of fresh air will be required, showing clearly that 3000 cubic feet per hour is required for every healthy adult. Please not to forget one word of this.

Now if we take the result of the combustion of gas (i.e. coal gas) into consideration, we have another very destructive element at work and which consumes from each three-foot burner as much oxygen per hour as is required for three persons.

If such calculations are beyond dispute, the question comes thus,—

Must not the condition of our work-people in closely confined, overcrowded, ill-ventilated workshops be something unbearable, and are not the consequences fatal either to the maintenance of a healthy body or a robust mind, and how is it we find bloodless lips, pale faces, flaccid muscles, spiritless bodies, amongst our juvenile operative population? The answer is plain; they are poisoned day by day, their vitality is impaired because their blood is deteriorated at every inspiration, and in an over-laden atmosphere, headache, lassitude and absence of nerve power are the result.

When efforts were put forth in 1815 to oppose the introduction of fresh factory legislation, and at a time when machinery was being turned out in a high state of perfection, Sir Robert Peel declared in the House of Commons, "that instead of the Law being a blessing to the nation, it would be converted into the bitterest curse;" that is, *if enactments were passed which could not be so carried out as to satisfy the full intentions of legislators;* and again in 1831, when fighting for the famous ten hours' bill, Mr. Sadler, then M.P. for Newark, the champion of the poor oppressed mill-hand, said, when pleading the cause of oppressed children, "what numbers of them are tethered to their toil, *confined in heated rooms*, bathed in perspiration, poisoned with the noxious effluvia of grease and *gas*, till at last *weary* and *exhausted* they turn out almost naked into the inclement air many of them diseased, stunted, crippled,

depraved and destroyed." So that if we look back to 1831, and then turn to 1884, might we not say "tempora mutantur, et nos (*non*) mutamur in illis," although then, there was no direct sanitative clause, whilst to day it is enacted that "a factory or workshop shall be kept in a cleanly state, free from effluvia arising from any drain, privy, or other nuisance, they shall not be overcrowded whilst work is carried on in them so as to be injurious to health, they shall be ventilated in such a manner as to render harmless *so far as is practicable* all the gases, dust, vapours or other impurities generated in the course of the manufacturing process or handicraft carried on which may be injurious to health." This clause applies to every factory and workshop in the kingdom irrespective of the number employed, it lays down a positive injunction (shall be kept in a cleanly state), the freedom from effluvia arising from causes assigned is intelligible enough, the overcrowding can be checked according to the standard laid down by the department, though not by Law, but when we come to ventilation, then the whole of the clause thereto appertaining is open to argument, if not to evasion; it says "in such a manner as to render harmless *as far as is practicable* all the gases, dust, vapour, or other impurities generated in the course of the *manufacturing process*," now it might be fairly asked, how can you define and put into practice, the words "in such a manner," &c., and how the words "generated in the course of the manufacturing process;" and who is to be the judge to what extent such applications shall proceed to be satisfactory? Does "generated in the course of the manufacturing process" exclude the ventilation which, in a workshop where no dust is generated, is so sorely needed? for it is possible to assume that the construction of the passage applies only to gas, dust and vapour, which are the outcome of the method whereby manufacturing is completed; if so, then ventilation, for the supply of free air, and for the expulsion of polluted air, where no dust, vapour or gas is generated, as explained, is outside the meaning of the clause.

I refer to this particularly, because it is so vitally important to the health of millions of workers, for I am of opinion that in the total absence of any definite regulation, together with the very great difficulties existing in many London places and elsewhere, that advantage may be taken of this proviso and be made an excuse for doing nothing, and moreover, when Inspectors are for the most part laymen, however well read and earnest, their ipse dixits cannot be accepted as the *intentions* of Law, when *no positive instructions are laid down.*

I am sure I shall be excused for saying this, because I see, day by day, places wherein persons are congregated which would not stand the test of any scientific investigation. The sanitary clause above quoted contains all that is enacted in regard to sanitative necessity, then under a subsequent section, it is provided that lime-washing, painting, scrubbing with hot water and soap shall be done every fourteen months to ensure cleanliness, but nothing as to ventilation. The next section refers to bakehouses, and repeats what I have just said, except that the lime-washing is to be done every six months instead of every fourteen months, and that the sleeping place shall be effectually separated from the bakehouse, and that windows of at least nine feet super, shall be glazed and external to the bakehouse, and that four and a half feet are made to open for ventilation. And in the next section, it is provided that where "grinding, glazing, polishing on a wheel, or any process is carried on by which dust is generated and inhaled by the workers to an injurious extent, and it appears to an inspector that such inhalation could be to a great extent prevented by the use of a fan or other mechanical means, the inspector may direct a fan or other mechanical means of proper construction for preventing such inhalation, to be provided, &c., &c." This is the whole of the Factory Act, 1878, which refers to cleanliness and ventilation. I will proceed a step further to try to prove my case. Many of you may remember that in 1881 I undertook to inspect all the bakehouses of the City proper, and that H.M. Chief-

Inspector published my report disclosing such horrifying facts as shocked the whole country; viz. the finding of filth, dirt, open sinks and closets in bakehouses, fowls roosting over a trough, rabbits dwelling in the bakehouse, cesspools running over into them, and many of these places being underground were dark, and not ventilated. I was induced in the following year to make another report with certain suggestions, and then a bill was introduced and passed into Law, which forbad bakehouse occupiers to have a water-closet, earth-closet, privy or ash pit within or communicating with bakehouses, that no cistern which supplies water to the bakehouse shall supply water to a water-closet, that no drain or pipe which carries off fæcal matter shall have an opening within the bakehouse. Therefore it is plain I think to any reasonable person that the law as to sanitation in bakehouses under the Act of 1867, was incomplete and useless. Again, in white-lead manufacturing, acknowledged to be a deadly process, there was no special clause other than the one I have quoted, except the prohibiting children and young persons from working in them, but when public opinion was roused to the fact that deaths from poisoning by lead fumes did take place, then another set of restrictions were placed on the statute book in 1883 by the side of bakehouses. And this too clearly showed that the process of white-lead making required some other and more stringent regulations to ensure the safety of the workers. And equally necessary do I conceive it to be, so to frame a clause on ventilation as shall provide *for an absolute minimum of cubic space for each worker*, a means whereby, if mechanical power is available, free air can be admitted and foul air expelled, and as in workshops, where no motive power is used, it shall be incumbent on every occupier to ventilate *on some defined system.*

A very great evil lies in the permission to carry on trades in old dwelling-houses, where room deemed to be sufficient for a family is made to suffice for 20 to 60 hands, in which artificial light is required continually, whereas if

suitable places were built, and proper sanitary appliances set up, if the cubic measurement were declared, and the inlets and outlets certified to be in *accordance with the regulations*, then we should have advanced to really something approximating the requirements or at least the intention of the Law; and moreover it might be asked, as I once was, if you find so many places wherein work is carried on contrary to the Act, why do you not enforce conformity as for other offences? I would say that it is perhaps owing to the wideness of the construction of the Law. It may be, too, that as from 1802 to 1883 very many Acts were passed which superseded former ones because too much rigidity was not at first infused, so may it be deemed necessary, after a fair experience of the working of the present Act to which the entire manufacturing community has been subject, to advance a few steps further in the direction I have suggested; for I am satisfied that however good and generous men's intentions may be, that in the relationship of master and servant, a wholesome and effective restraint, no matter in what aspect it might be, is the very truest bond for commercial peace and prosperity, and to none of them should an effective law, which ensures health and comfort to workpeople, give place. Ventilation may be classed under three heads—(1) Mechanical means to carry off impurities generated in process of manufacturing. (2) Mechanical means to carry off noxious gases and vapours. (3) Ordinary means for ventilation in workshops where no mechanical power is used.

The first refers to Textile Mills, wherein fibrous matter, dust and filaments are given off, and to which the system of ventilation by propulsion is the most effective. The second would include Bleach Works, Dye Works, Calendering, Distilling, Brewing, gassing rooms and all places where the air becomes vitiated by vapours. The third would apply to workshops and factories in which the evils of insanitation abound, and as I said can be traced to the conversion of dwelling-houses into manufactories, wherein, according to the evidence given before the Parliamentary

Commission in 1876 ventilation was totally neglected. Where no mechanical power is available a simple system may be adopted which would materially improve the atmospheric condition of workshops, provided the effects of gas illumination were negatived.

Currents of air can be led to outlet upcast shafts whereby an exhaust is created, and a gas jet burning in the outlet shaft will greatly add to the effectiveness of the contrivance. Then there is the extracting ventilators, though they depend much on wind-currents for results, but when well fixed on the top of the upcast, and are of the most approved principle, such as the Howarth Archimedean Screw, they seldom fail. We can also add to the currents by utilising fire-places, which, if aired by proper inlets, will promote an efficient exhaust. What I would say is, that where there is a will, there is a way, for Nature's laws are not so complicated in action as to puzzle the scientist, or to compel persons when striving to promote ventilation to expend much money upon it. For as proof thereof there are to-day, many occupiers in London who have been good enough to accept my suggestions, and who will say that ventilation can be effected cheaply and satisfactorily.

To show you how needful ventilation is, I will give you two examples out of many.

Picture to yourselves a ten-roomed house, once a dwelling-house, wherein sixty persons are employed, each room not exceeding in cubic capacity 1728 feet, in some of the rooms will be found ten persons, a gas jet for each two, temperature 94° at 8 P.M.; doors and windows shut, ceiling low, females found quite worn out and perspiring freely, the air in the room breathed and rebreathed, and where from excess of carbonic acid given off by the lungs and from the addition of watery vapour and animal effluvia given off by the system, the expired air when reinhaled becomes dangerous; where this exhaled vapour is found to be condensed on the walls, trickling down the window-panes in polluted streaks, and when assisted in the completion of pollution by the products of gas combustion,

the air in said room is absolutely dangerous. My second illustration is a printing-office of the old type, the building was once a dwelling-house, and of the same size as the preceding case, the machine room below the road, the ceiling eight feet high, machinery crowded, so that it is difficult to move between it, shafting and belting, wheels and cranks in rapid motion, refuse lying about, floor broken, a boiler and engine in one corner, a closet without water and not ventilated in another corner—the type-washing tank next to it, which is filthy, the whole room completing a picture of a deleterious den, in which men and boys work without vests, shirts open, they reek with perspiration, and lash cardboards to the shaft as the only appliance available to produce undulations, gas burns here all day, and the thermometer will register 92° to 94° at night. I might travel over the whole range of industries which are carried on in these converted dwelling-houses, and cite cases where no attempt at ventilation has been made, and I can fairly repeat what I noted in my handbook that not one workshop in a hundred is ventilated upon any scientific principle. If we can see printing-offices fitted with every modern appliance for ensuring sanitation and ventilation, where ample space is allowed and light sufficient, where the machine room is large, cleanly and airy, where engine and boiler are in their proper houses apart from the work-rooms, and wherein employment is carried on in every way satisfactory, one would ask if this is the consequence of the requirements of the Factory Act, or is it the independent doings of the occupier. If the former, then all should be served alike, but if the latter, then the law is not absolute. I would implore employers of labour to see to this, I would ask them to consider the terms upon which they engage free labour, and I would further ask *if it be* free labour which condemns people to a lingering decay. If you want help or advice, you all know how ready I ever am to give it, for time or trouble do not enter into my day's work, and if I can succeed in inducing London occupiers to devote attention to this most vital subject, as

they have so kindly done in fencing their machinery, I shall be proud enough to know that here, as elsewhere, I have not lived in vain. Your duty is paramount to your own lives, your responsibility is put upon you for the upholding of the peace, prosperity and progress of the nation, and if by producing, you enrich yourselves and others, let the others include the units of industry whose services you require.

In the diagram before you I show three buildings. One, a factory using motive power, and whose position is favourable to the adoption of the exhaust system. You will perceive the inlets arranged on the left-hand side, wherein free air is constantly introduced without draught, this air will ascend a little, and then, when warmed, fall under the influence of the ventilating shaft, which is carrying off the spent air by the exhauster fixed on its top, and which is driven by the shafting and pulley above. You will perceive, at each floor, an opening into the upcast, which prevents any appreciable quantity of air, on its way out, from entering the room, but which, acted upon by the exhauster, will draw up air equal in proportion to the power of the exhauster if the outlet be correspondingly large. In the second factory, where motive power is used, we have three sides shut in, so that air must be drawn from the front side only—on each floor a number of Tobin's tubes are arranged, and by a system of cross ventilation, the exhauster and upcast shaft will do the work. In the third, where no motive power is used, three plans are shown—one by Dr. H. Stallard, having the merit of attaining to an evenness of temperature by the use of a perforated ceiling, a space between this ceiling and the true one is converted into an air-chamber and open to the atmosphere on all sides. By this method natural ventilation would be assisted, and without exposure to extremes of weather, the conditions of living in the open air would be supplied. The second method, devised by Mr. Hinckes Bird, consists of raising the lower sash of the window, and filling in the opening under the bottom of the sash with a close-fitting

piece of wood. A corresponding space between the sashes is left, through which the current of fresh air enters and is *directed towards the ceiling.*

The third method is simply by the application of what is called the Tobin system. Fresh air is introduced by means of vertical tubes, carried up the walls about six feet high, so that no down draught is felt, and if, as shown on the left-hand side of the diagram, a shaft be set up from basement to roof, having outlets on each floor about a foot below the ceiling, and communicating with the upshaft, together with a gas jet introduced at top floor, the whole surmounted with an effective ventilating cowl, I venture to think that there would be a continual interchange of atmosphere without any draught.

The model which I show you has been prepared by the Blackman Propeller Company, and which is represented in the diagram. The propeller is exhibited here, and so is Mr. Hinckes Bird's system. The propeller will remove impurities at the rate of 15,000 cubic feet per H.P. per minute. It is simple in construction, and can be easily applied to any building whether for propulsion or extraction.*

In concluding this part of my lecture I would strongly advise the adoption of some method for carrying off the products of combustion of coal gas, which can easily be done by having a long tin tube provided with a funnel-shaped opening over the gas jets carried between the joists above the ceiling and communicating with the chimney or open air—for if this system were tried and found to be successful—and I know by experience that it will not fail—one of the greatest evils accompanying employment in factories and workshops would be removed. I must now very briefly allude to sanitation and where defective.

* The smallest size can also be used by hand, and is very effective in workshops where occupiers use only one room.

SANITATION.

I find that I have consumed a large portion of my allotted time, but having much to say on the importance of sanitation, or rather, the evils of insanitation, I will trespass on your indulgence and ask you to remain a little while longer. You have been most complimentary, and have paid great attention to what I have said, so that I am strengthened thereby in my desire to proceed.

Sanitation.—What it means when applied to workshops.—Under the head of sanitation I would include cleanliness, regularity in employment, the granting of proper times for meals and rest, the enjoyment of fresh air and a total absence of noxious gases.

If in any factory or workshop such conditions could be found, we should say that the said places were kept in conformity with the law. If the law were made by reason of the great necessity existing for the removal of evils to which operatives were exposed, ought we not, after so many years of inspection to be able to say, that generally, the sanitary clauses of the Act of 1867 are respected? If we cannot say that they are, can we venture on any opinion to show why they are not?

Our industries are so numerous and varied, that special adaptations to each trade would seem to be necessary in order that every hindrance to the securing of health to operatives might be removed; but it really is not so, although appliances necessary for one class of factories would be inapplicable to another, or in workshops where impurities of different orders exist, various means may be necessary, still, they are all of a kind, and a system suitable for one factory, would, with fair adjustment, be applicable to all.

Workshops under Act of 1867.—I shall make no further reference to textile mills, or to those trades under the Act of 1864, for I have shown that the evils therein found have been fairly met; but what we have princi-

pally to contend against, is the insanitary condition of factories and workshops brought under the Act of 1867, which in their processes of manufacturing do not generate impurities, but which are unhealthy from situation, overcrowding, and want of sanitation, subtle evils, unseen, but felt. In those we have to undo custom, and to subdue indifference, for the very root of the evil lies in utilizing places totally unfit for manufacturing purposes, and were it not a fact, that workers in many of those industries are not accustomed to a much better state of things in their own homes, they could not possibly endure the passing of their days in such unhealthy places. I shall rejoice to know that the enquiry so extensively made as to the dwellings of the poor will eventuate in some potent regulation, commendable to the people themselves, and then we may look forward to great improvement in the sanitary state of our workshops, especially in those where females are employed.

In England we boast of our cleanly homes and thrifty habits of our housekeepers ; but if you could see the waste of food, the slatternly doings, the throwing of refuse anywhere, the utter disregard of cleanliness found amongst many females in certain trades, you would sympathise with masters in their non-ability to keep their workshops clean, and I believe that to a large extent this is the reason why so many of them are indifferent to this most important requirement.

But such an admission does not of course extend to structural defects, to overcrowding or insanitation, for what vigour of body can one possibly expect to find amongst persons congregated daily in a small house cut up into little rooms, where the staircase is narrow and tortuous, the ceiling low, the doors and windows close together, the closet either on the landing outside the work-room, or in the very room, without ventilation, and only one such place for sixty or seventy persons, where the water supply is gone by dinner time, where the drinking water is taken from the cistern which supplies the closet, where pipes from cistern to closet will not prevent the introduction of gas from the latter into

it, where there is no outlet for gas from pan to outer air, or indeed any syphonic adaptation, where coal gas burns in excess and in winter all day, where, for example, ten burners are found in a room containing three thousand cubic feet of space or less, and wherein ten persons work, and when night comes on with windows and doors shut, and where ventilation is not provided?

One can imagine how fetid must be the air, and how enfeebled must be the workers, who are struggling to catch a little air which the coal gas is consuming.

If I find you such places, would you consider them to be in conformity with sanitary law, and if not, is it unreasonable to ask why they are allowed to continue?

But if to prohibit employment in all such places were possible, we should, I think, do an incalculable mischief by exercising such a power as would not be upheld; clearly then, in the absence of such an authority, and for want of a sufficiently well-defined Act, we can only advise and recommend where possible, although there are hundreds of places where much good could not be done, and in which, proof of degree of insanitation would be cast on the inspector without any defined law to guide him. When we think of the numbers of small men striving to get on, who cannot embark on large enterprizes, but who would do more to improve their workshops if they could, ought we not rather to help them on, than to cripple them in their struggles by too stringent an Act, which would promote monopoly in manufacturing, such as this country would never submit to?

This is the other side of the case, and proves how grave and serious is the question which custom has raised, and which restrictive law, as it stands, does not effectively meet, and therefore the pleadings of an Inspector, however potent, cannot avail unless accepted by willing occupiers.

The evil has grown to large proportions; so that occupiers do not think upon sanitation so much as, how many persons can be put into one room, so that the cost of production shall not exceed a certain limit, a further outlay

for ventilation and for purifying would be deemed to be unremunerative. So we go on, year after year, and I venture to predict that we shall so continue until the Act on sanitation shall pronounce as distinctly as it does on other restrictions in employment, for if certain defined regulations were laid down, I am persuaded that sufficient buildings would spring up, specially adapted for each trade, so that if an occupier required one room or more, he could find them, as in cotton, worsted or woollen mills, or in the cabinet trade in London—only let the axe be applied to the root of the evil, and the upas tree would quickly fall. And further, as to the regulations hereon, it would surprise you to know that if I found an insufficiency of closet accommodation, or none at all, I have no power to compel others or any to be set up. The Local Authority must step in, under the request of Her Majesty's Inspector, or upon his own authority, to do what Her Majesty's Inspector finds necessary; and in every domestic workshop, that is, where members of the same family work in their dwelling-houses, or in workshops where only male and female adults work, in neither place can an Inspector of Factories interfere as to sanitation, but he must relegate that duty to local officers, although in the weightier cases of large factories and workshops, where hundreds of persons of all ages work, he, and not the local authority, has full power to administer the sanitary clauses; so that it would seem strange, and I doubt not, does seem strange to you that the provisions of the Public Health Act, 1875, should give such power, and that the Factory Act should require its officers to communicate with local authorities in lesser cases.

I submit that a dual authority in all matters is a source of weakness, and in fact useless, and I venture on the opinion that if the local authority, knowing their responsibility in this matter, had exerted themselves as far as in them lay, I should not to-day have it in my power to make such disclosures as recent special visits to certain places enables me to do.

The sad condition of closets is the most objectionable

feature in London workshops, whether as to position, or water supply or ventilation, many of them are fitted with unsyphoned pans, open, and at times, especially at night, the smell is very offensive, and after gas has been lighted, the evil becomes intensified.

The occupier will excuse himself, and lay the blame on his workers, who are said to be dirty and negligent, or on the water company for too small a supply—or on the landlord who refuses to spend any money on his premises—but it is very evident that want of structural design has much to answer for in the arrangements of closets, such for instance as are found one above the other, one on each landing, and where each discharges into the same soil pipe, whence gas is admitted into the workrooms because the underneath pans become unsyphoned from the flush of uppermost closet, for the want of a proper air inlet at base of pipe—and again, the pan closet is not a good system for London, for between the pan and trap, the container is a receptacle for foul air which passes through the water by absorption, or is displaced into the building when the closet is used, and if the soil pipe be inside the workshop, which is generally the case, the escape of dangerous gas must follow if any part of the said soil pipe be faulty.

Therefore do not have pan closets, but properly syphoned pans, such as you can see in this building, and which to my mind is one of the most attractive features of the Exhibition.

Lavatories and urinals in our workshops are also set up "by rule of thumb," anyhow, so that liquid is carried away; they are not properly trapped, and the water passes into the soil pipe of W.C. below the pan, so that sewer gas has a *main artery* for diffusion amongst workers. The washing tanks of many printing-offices are not much better, offensive and untrapped. People will not think that gas is subtle and permeates from ever so small a defect; and I would warn occupiers that the existence of a smell when not accounted for, means a hidden mischief which should not be neglected.

Meal hours.—I now proceed to the taking of meals. How much can be said about the preparation of food in workrooms close to ash-pits, or upon gas stoves, by side of glue pots boiling over, or upon a fire where cauldrons of paste and alum are placed, or over gas jets which send unconsumed carbon into the food.

If we look into the factories in the noble counties of York and Lancaster, where health, happiness, and intellectual advancement are so much promoted by the establishment of dining-rooms, reading-rooms, sick societies, libraries, and improved dwellings for operatives, one can see much that is mindful of the wants of others without the intrusion of the calculation, what gainer the occupier would be if he kept his money, rather than by expending it, he provided suitable premises as to room, light, and comfort for his work-people.

I have found this generous spirit in London also, in many factories and workshops, and I know to what extent it is appreciated; and I hope that with the development of art in building, architects will henceforth assign a margin of space and cost for the sanitary requirements of each new factory or workshop, so that manufacturing convenience may no longer absorb every other consideration.

Few persons will deny that food, if hastily taken does not nourish the system to the extent that it would if eaten in leisure. The law requires that one hour should be given for dinner, and half an hour for tea. In factories where motive power is used, this time is taken, because workers cannot go on without the engine; but in places where no motive power is used, and where work is paid for by the piece, females especially are very apt to eat and work together, or to eat their meal as quickly as possible, and then to resume their work without a change of position or temperature. We are told by masters that it makes no difference to them, and if their hands will do it, they are powerless to prevent. This argument is fallacious and dangerous, and subjects such masters to a fine, for although neither he, nor the overlooker, be present during meal-

times, such a system ought not to obtain, even though it be found amongst the poor paying trades.

This restriction is wisely enforced even when workers are seemingly unwilling to accept it, but if people will so foolishly eat, drink, and work together, no master would care to remain on his premises to see if the law, as to cessation of work be respected, but depend upon it, this is an evil, and should not be permitted, and I would advise workers, especially when working overtime, to enjoy the full time for meals as the law directs, and if possible to walk out and to change the temperature of the workrooms.

Overcrowding.—So grave was this evil found to be, that I had the sanction of H. M. Chief Inspector to prosecute an occupier in London for continued neglect therein.

Let it be known that there is no standard laid down in the Factory Code as to what shall be the minimum amount of cubic space for each worker, but it was decided at the hearing, that 300 cubic feet should be the minimum to be allowed to each worker—but when we consider that the condition of thousands of factories and workshops is left to be governed by other than definite restrictions, no great success can possibly follow individual exertions.

It has been laid down that we must be content with 250 cubic feet per head for day work, and 400 for night, which, if not allowed, is deemed to be a contravention, but in so wide and difficult a question, an insistance on specified regulations would enable inspectors to proceed on definite lines, incapable of misconstruction, and moreover, occupiers, knowing what the law requires, could not plead ignorance when pressure is brought to bear.

Where there is no ventilation in workshops except by doors and windows which, when working overtime to 10 p.m. are, if possible, closed, the insanitary state of the rooms is very great—it is not a state of things to be desired to find overcrowding by females, bending over their work at sewing machines with gas jets close to their heads, and in rooms where no free air can enter in sufficient quantity to do them good—as I have said, their

countenances are pallid, the eyelids and lips are bloodless, the body wearied, and no surer friend to lung complaints can we have than these vitiated overcrowded workshops.

If the standard of purity were insisted on, below which the maintenance of perfect health could not be preserved, then not one workshop in the City of London would bear the test. And in this assertion let me be particular. I affirm that in the months of October and November in the City of London, from 7 p.m. to 9·30 p.m., there will not be found half-a-dozen workshops or underground printing-offices which will show as low as ·6 of carbonic acid per 1000 volumes of air, for in the former, the rooms are very small, gas in excess, no ventilation, with cubic space insufficient; and in the latter, much heat is evolved from boiler, engine, gas, and refracted heat and pollution of air, and where there is no ventilation to machine room or closet. If I state what is correct, I ask you again, if such things should continue, and where is the remedy?

Domestic Workshops.—Domestic workshops, as afore alluded to, are increasing in number, by reason of the division of labour in many industries, notably in the shoe and boot trade, in mantle-making, tailoring, fur and feather trimming, each presenting all the features of a dirty home and the carrying on of dirty trades therein, where children and young persons dwell amidst dirt, squalor, and complete wretchedness. To deal with them is not within the scope of factory legislation, only so far as the extent to which the labour of the young is carried on; therefore sanitation remains exclusively under local authority, whose functions are limited, and who were empowered to cause the removal of nuisances rather than to prevent disease. If persons were anxious to see the amount of destitution, however caused, and the condition of domestic workshops, they have only to walk through the streets right and left of Bethnal Green, Hackney Road, Whitechapel Road, and through Spitalfields, when they would be convinced that life under such conditions was anything but cheering.

I must mention one trade of all others which presents

features the most unusual, and which is governed by a system the most uncommon that I have ever seen. It is very extensive, employing many thousands of male and female workers, who, being chiefly foreigners and have migrated into this *free* country from the oppression of others, may perhaps have thought that once here they had arrived at the "El Dorado" of their hopes, and that wages high and continuous would have been easily secured,—a trade carried on exclusively by the subdivision of labour system, in which no skilled workman is found, but where an infinite number of garments are made for the home and export trades; I refer to the East-end tailors, or as they are called, the East-end sweaters; but as the trade is divided into three sections, I only refer to the third or lowest, who take up what is left by the other two in low-class goods, and from the smallness of the price paid, work all day and night to secure a living. In a report I made in 1881 I fully showed what toilsome lives these people passed, miserably poor, struggling against oppression, over-weighted by landlords, who exact high rents for tumble-down houses, where damp comes through the walls; doors and windows patched up, foul odours prevailing, sinks untrapped, closets without water and horribly stinking, where one can see food cooked in those filthy courts close to closets, and piles of garments lying on dirty beds, or on heaps of cloth cuttings, or hung up amidst the smoke and vapour and gas and heat which are given off from coke fires and coal gas combustion.

I have called meetings, and have addressed these people. Influential Jewesses have kindly lent their aid; the Jewish papers have also helped us on towards an improvement. The wilful transgressors have been fined for illegal employment; and now, under special inspection, we do hope to help these poor people who, unless protected, may live and die in misery, uncared for and unknown, as unqualified examples of the "Sic vos non vobis" principle.

I might continue my address for another hour in depicting the evils consequent on many kinds of employ-

ment, but I think I have adduced instances enough to convince you that our operatives do not enjoy benefits to the extent contemplated by the law.

I hope, however, that the influence of progress will supplement the law; and that, in such places as I have alluded to, we may ere long be satisfied with the result of private enterprise; but I doubt it, I do not believe in human excellence, nor disinterestedness, but I do believe in definite and wholesome legislation.

"Why should London wait?" has been rung in our ears, and I would ask, but with different intent, why should London wait in the enforcement of its sanitary enactments, whether by imperial or local means, until it shall have been overtaken by some serious calamity? Why do we permit our people to be closely packed in houses, amidst the accumulation of refuse and dirt, and with filthy closets under their noses? I have seen sights in London which I have no power to remedy, sights which would appal those eminent authorities who can so well weigh cause and effect.

For twenty-three years the bakehouses were left as the law found them, but my report of two years' inspection startled the country, and incited a speedy application of fresh legislation, and the erection of hygienic bakeries.

So generally, is it right, that people should be convinced that sanitation is of all sciences the most neglected, and the most pressing? It seems surprising that large buildings should be continually erected in this city for manufacturing purposes without the slightest consideration for sanitation and ventilation, which have been sacrificed to commercial needs, although for its full development it requires health and strength in its workers. It has been said that one-third of the preventible diseases in this country are due to want of healthy dwellings and workshops, and to defective drainage, which could and should be prevented, and until the necessity for sound sanitary legislation be carried home to each person, we must educate the public in the important elementary details of domestic sanitation.

We want sanitation to be our work; we do not wish to

see families huddled together, eating, drinking, cooking, living, sleeping in one room, with articles whereon they work strewn about, the bed rolled up in one corner and sanitation utterly neglected; where in one instance as many as thirty-eight persons have been found in an eight-roomed house, a family in each room, where below, a most filthy closet was seen, and an untrapped drain, wherefrom sewer gas ascended, the drinking water was contaminated, so that people cried out shame at the continuance of such things.

Remember, these wretched inmates are industrious, very poor, victimised by those with whom they have to deal, and withal making something which other people want. Look at the loss we sustain nationally, for if the average life was increased from two to five years, we could compete more successfully with foreign labour, and ten hours' work under sanitative regulations could be better endured than half the number as we now are.

In conclusion, I have only to add, that I fervently wish that every man who is entrusted with so sacred a duty as the enforcement of sanitary law amongst our operatives, whether in workshops or at their homes, may evince devotion, energy and capacity to and in his work, and I further hope that administration may be ably continued and supervised, so that we can look to ourselves with much satisfaction as a body of Government servants capable of, and willing to deal with each new feature in manufacturing which our continually developing commerical prosperity is sure to present, and who can assist and also guide in the increased responsibilities of the work which borders upon the necessity for a scientific knowledge, so that inspectors of factories can and will rise to the higher sphere of education now so very necessary to the attainment of the realization of our hopes, viz. the securing of the blessings of "Health in the Workshop."

SMOKE ABATEMENT.

BY

ERNEST HART,

CHAIRMAN OF COUNCIL OF THE NATIONAL SMOKE ABATEMENT INSTITUTION, AND OF THE NATIONAL HEALTH SOCIETY.

JULY 21ST, 1884.

A LECTURE ON SMOKE ABATEMENT.

By ERNEST HART,

Chairman of Council of the Smoke Abatement Institution, and of the National Health Society; Member of the Executive Council of the International Health Exhibition.

Sir FREDERICK POLLOCK, Bart., in the chair.

THE CHAIRMAN, in introducing the lecturer, said the subject of smoke abatement was one of very great importance, and one to which Mr. Ernest Hart had devoted a great deal of time and attention. By the ability and energy which he had shown in initiating and directing the work of the Smoke Abatement Committee, he had done a great deal towards reducing the nuisance of smoke in London. However, still more remained to be done; activity on the question was going on on the part of the Smoke Abatement Institution, into which that Committee was now transformed, and the desirable thing now was to diffuse all the information possible, to point out the best remedies and to induce the public to adopt them. With a view to extending knowledge upon this subject, Mr. Hart had been good enough to come this evening in order to give any assistance that he might be able.

MR. ERNEST HART: There are so many sides upon which the question of smoke abatement may be considered, and there is so much to be said both from an historic point

of view and from the point of view of present action, that it is impossible that I should treat all parts of the theme in the short half hour to which these lectures are in mercy to their audiences usually confined. I shall not therefore to-day say much upon one aspect of the subject on which it is, however, extremely and essentially necessary that there should be some public enlightenment, I mean the subject of combustion generally, but I shall refer to the present and past position of smoke abatement as an administrative and legislative, rather than as a purely scientific movement. I have some hopes that other members of the Smoke Abatement Institution, specially well qualified to deal with the scientific part of the question, such as Professor Chandler Roberts, or Captain Douglas Galton, will, at a later date, deal with the technical side of the question.

The question is not a new one in this country, but has a history extending back nearly 600 years. We find that in the year 1306, when coal had come into considerable demand in London, Parliament complained of the injurious effects to health and property arising from the use of coal, and the king adopted an effectual means of checking the evils arising from smoke, for he absolutely prohibited the use of coal. Later on, in the reign of Elizabeth, a motion was introduced into Parliament to prohibit the use of coal on account of the noxious vapours and smoke arising from it, which were considered very prejudicial to the health, especially of persons who were unaccustomed to it.

From this time the minds of public and scientific men were occasionally exercised in protesting against the evils of smoke production and in devising suitable means for its abatement. But it will only be necessary to allude to Sir Hugh Platt in 1594, to Evelyn's eloquent protest in his *Fumifugium* in 1661, to Benjamin Franklin's efforts in 1745, to those of James Watt in 1795, and Count Rumford in the first decade of the present century, in their well-sustained warfare against smoke and its attendant evils. In 1819 the national importance of the smoke question was admitted in a very practical way by the appointment of a

Select Committee of the House of Commons, "to inquire how far persons using steam engines and furnaces could erect them in a manner less prejudicial to public health and comfort." The Committee reported that "so far as they had hitherto proceeded they confidently hope that the nuisance, so universally and so justly complained of, may at least be considerably diminished, if not altogether removed." In 1843, another Select Committee "inquired into the means and expediency of preventing the nuisance of smoke arising from fires or furnaces." The list of witnesses examined by the Committee comprised the honoured name of Faraday, and, as their Report points out, "they received the most gratifying assurances of the confident hope entertained by several of the highest scientific authorities examined by them that the same black smoke proceeding from fires and private dwellings, and all other places, may eventually be entirely prevented." They concluded by recommending "that a Bill should be brought into Parliament to prohibit the production of smoke from furnaces and steam engines." In May 1845 yet another Select Committee of the House reported "that in the present state of knowledge and experience upon the subject, it is not desirable to extend the provisions of an Act beyond furnaces used for the generation of steam."

In August 1845, Sir Henry de la Beche and Dr. Lyon Playfair reported to Lord Canning "that it cannot for a moment be questioned that the continued emission of smoke is an unnecessary consequence of the combustion of fuel, and that, as an abstract statement, it can be dispensed with." They added, however, "it is useless to expect, in the present state of our knowledge, that any law can be practically applied to the fireplaces of common houses, which, in a large town like London, contribute very materially to the pollution of the atmosphere."

It was not, however, till 1880 that a substantial attempt was made, by the National Health Society at my instance and with the co-operation of Miss Octavia Hill on behalf of the Kyrle Society to organise public opinion and scientific

research; nor was it till the formation of our Smoke Abatement Committee in 1880 (see *Sanitary Record* for Nov. 15, Dec. 15, 1880, and Jan. 15, 1884) that any substantial effort was made to ascertain what the present state of our knowledge of the subject generally really is. An interesting series of reports published from time to time mark the stage of progress which has now been reached, and I shall have occasion later on to show how abundant have been the results of the labours of this Committee during the three years that we have been at work; one result of their work is shown in this Exhibition and elsewhere by the large number of persons, representing all classes and interests, who are now fully sensible of the importance of the subject; and, further, there is abundant and satisfactory evidence, in London and in the chief provincial towns, of anxiety to adopt any improved appliances for burning fuel, or any smokeless forms of fuel, when their merits have been fairly proved.

The Smoke Abatement Exhibition which we organised in 1881 (see *Sanitary Record* for Dec. 15, 1881, Jan. 15 and Feb. 15, 1882), in part of these buildings placed at our disposal for the purpose by the Royal Commissioners, with the approval of the authorities at South Kensington, stimulated and encouraged inventors, manufacturers, and others, and aroused a healthy spirit of competition in the production of smoke abating appliances. At the Smoke Abatement Exhibition, buildings were fitted up for the purpose of testing the efficiency of grates, stoves and other appliances suited for domestic use; and trials of various fuels and boiler appliances were also provided in the Exhibition buildings, in the Royal Albert Hall, and at certain factories where facilities were afforded. This series of mechanical and physical tests were conducted by Mr. D. Kinnear Clarke, C.E., and the chemical investigations on the effluent gases of the flue by Professor Chandler Roberts, F.R.S. The results obtained by these gentlemen and by their competent assistants were of a unique kind, and no pains were spared to ensure their completeness. The results are preserved in

a permanent form in the Report of the Smoke Abatement Committee of 1882, published by Messrs. Smith, Elder & Co.* It would be well if architects and others officially concerned, and all persons whose duty it is to determine on the question of rates, were to consult that report. Quite recently I found that two of my friends had placed themselves in the hands of eminent architects and asked them to fit up suitable grates for the prevention of smoke. In one case the gentleman who stands in the foremost rank of his profession frankly avowed himself ignorant of the subject and under some unhappy inspiration chose for this new mansion the class of grates which was shown by the test at the Smoke Abatement Exhibition to produce the very worst results, and in the other case the architect, who was one of the most eminent architects in the kingdom, said he did know all about the subject, and yet, strange to say, he chose the same grate, which proved that he had never even looked at the results which had been obtained, and was still in a state of dense ignorance of the results actually achieved, and of the facts proved. Only two days ago I met in this Exhibition a gentleman who is the architect and adviser for one of the largest building estates in the kingdom, and I found he had never read this report or ascertained what were the results arrived at upon the subject. He asked me, "Have you come to any result—what can I advise, is there any grate at all which will lessen smoke? Have you got any result?" He was so great a man that I did not like to tell him the results had been under his eyes for some time, so I promised to take him over the present Exhibition and point out some of the results of the Smoke Abatement Exhibition of 1881, and to bring under his attention some of the successes which had been attained. That is not very encouraging, but I can only hope that as we have made those results available to the public, and as our opinion can be brought to bear upon these learned gentleman—learned in their own profession and able to appreciate,

* These results are discussed and summarized in the *Sanitary Record*, for Feb. 15, 1883.

although regardless at present of the results obtained by others—that they will give attention to those results. I am bound to say that I consider it not altogether creditable to the Royal Society of Architects or to any of the great architectural societies, that some one of their members has not abstracted and criticised for the use of these societies the practical results which have been obtained by these physical and chemical tests, and that architects as a body seem at present to be quite unaware of their extent and importance, and to have learned none of the lessons which are clearly set out. I venture upon this somewhat strongly worded expression of opinion because, with the great respect which I have for those gentlemen, I believe that practically at the present moment it lies very much in their hands whether the information and the conclusions which we have obtained shall be buried, or whether they shall be vital and progressive and lead to the great results they are capable of leading to, especially with respect to new houses. I think it little less than a scandal that, notwithstanding the promises which have been made to us by the heads of many of the Government Departments, no systematic steps have yet been made, and more particularly by the Department of which my distinguished and able friend Mr. Shaw-Lefevre is the head, to apply these results. Some time ago trials were carried on at the Arsenal and very good results obtained, of which the First Lord of the Admiralty must have had cognizance, and yet no steps have been taken to make the results available either for the Institution or the Arsenal, to which it was promised they should be made available, nor to any of the ships of Her Majesty's Navy. When I had the honour of going through the Exhibition with that most intelligent and distinguished lady the Empress Eugenie, I found she was not only extremely interested in the question from the domestic and sanitary point of view, but she at once said, "This is a matter of great importance to ships of war, and that is what interests me. When a steamer is seen at a distance the first thing you see, and the first thing which gives notice to an enemy

which approaches, is the steam coming from its funnel." She said, "I feel interested in this for the sake of the war vessels as well as for the sake of the ordinary abuse in the production of dense smoke in steamers which traverse the rivers of our great towns." I am bound to refer to these instances, owing to the indifference shown to the results already obtained, because I believe that nothing but a strong public opinion brought to bear upon the heads of departments, and upon the respective technical professors, and the respective professional men employed in the construction of houses and the sanitation of cities will make the results which we have obtained fructify, or will lead to the progress of which the first elements are undoubtedly already practically furnished in this most valuable report.

In the remarks which follow, I propose to deal: 1, with the objections which have been raised to the prosecution of the movement; 2, to trace the steps which have been taken in collecting evidence as to the extent to which the evil exists, and the possibility of abating it; and to indicate the individual efforts which appear to be demanded by the evidence adduced; 3, to offer a brief statement as to the results which have been attained and are within reach.

Some objection has been made to the movement, on the ground that it is not a new one, and that the public have had the evils arising from smoke so fully brought before them as to render unnecessary the formation of a society for the purpose. It is true, as we have already seen, that the movement is not a new one, as it existed in a crude form from a very early period. Royal proclamations prohibited the production of smoke, and various appliances for preventing its production were devised, but until the formation of the Smoke Abatement Committee, over which I have had the honour to preside, in virtue of my labours in initiating it, the subject had never been treated as one of public importance, and even national interest, nor had the description of the extent and character of the evils associated with the production of smoke been brought in a clear and definite way before the public.

It has further been urged that since the continuous efforts of our forefathers for more than five centuries have been ineffectual in devising an acceptable and efficient means of burning coal smokelessly, therefore the problem may be regarded as incapable of practical solution. If any argument were needed to refute so illogical a conclusion it would be found in the present advanced state of our scientific and technical knowledge as compared with that of even a century ago.

It has been urged that the saving in fuel is small and does not become an inducement for the adoption of smoke abating appliances. This is sufficiently disposed of by facts of which I purpose putting one or two before you.

In the Report of the Smoke Abatement Committee you will find it stated that the whole of Messrs. Minton's great potteries and porcelain works are being conducted practically without smoke, and at a saving in fuel and labour amounting together to about 40 per cent.: a careful account of about 5,000 firings under the new system showing a saving of about 20,000 tons of coal of the value of upwards of £10,000, and in addition to this there is a saving in wages and a better production of ware. These facts do not come to us secondhand or of doubtful authority, but are set out in a detailed statement made by the manager of the works, with the assent of the firm, at a meeting at Grosvenor House which they attended for the purpose.

Mr. Alexander Fraser, the manager of Messrs. Hanbury's brewery in the East End of London, has borne like testimony at a meeting held by the Smoke Abatement Committee at the Mansion House, to the facility with which they have, during a long series of years, conducted the operations of their business smokelessly, and to the saving amounting to £80,000 in about thirty years, which they had realised in the cost of coal.

A large firm of sugar refiners at the East End have since our Exhibition fitted an improved furnace to their boilers of 100 H.P. (tubular type). They now state that

they "find the smoke burnt perfectly, and a saving of coal, which, in this particular case, amounted to 40 per cent. of the coal burnt."

There were recently estimated to be 4,000,000 chimneys in London, about 5,000,000 tons of coal being annually consumed. The coal wasted was put at a million sterling, while Mr. Chadwick estimated the additional loss arising from the damage caused by smoky atmosphere, at two millions.

The late Dr. Angus Smith says, with regard to the use of coal for industrial purposes, "The ammonia from 1,000,000 tons of coal, if used in manure as ammonium sulphate, would add about £533,000 worth of food to the produce of the land; while, if the ammonia from all the raw coal now burnt in this country was utilised in agriculture, we should add £50,000,000 worth of breadstuffs, and might begin to export." (See *Sanitary Record* for April 15, 1881).

The First Commissioner of Works, the Rt. Hon. G. J. Shaw-Lefevre, said (speaking at the Mansion House), "I may mention as an illustration of the cost of renovating our public buildings, that one public building alone, the Houses of Parliament, costs the country £2,500 a year for the renovation of its exterior alone, owing to the destruction of the beautiful carved work, caused by the rain-water being so highly charged with carbonic acid gas; and I have no hope that cost will be diminished until some remedy is applied to the smoke grievance."

Professor Chandler Roberts, F.R.S., has shown by a course of carefully conducted tests of the gases or smoke given off from domestic grates of various forms, that the weight of the smoke cloud which daily hangs over London may be estimated at about 50 tons of solid carbon, and 250 tons of carbon in the form of hydrocarbon and carbonic oxide gases.

The value of coal wasted from domestic grates in London alone, calculated from the average result of the actual tests made by the Smoke Abatement Committee, reaches upon the annual consumption of five million tons, £2,257,500,

that is, reckoning the value of the coal at 21*s.* per ton only, and assuming that all the grates in London are equal to the average of those tested at South Kensington, which showed that 42 per cent. of the total heat generated passes away without being in any degree utilised in warming the room. It must be remembered that the conditions under which these tests were made, were much more favourable (say in respect of careful stoking) than would be present in ordinary use, where the loss would consequently be proportionately greater. Beside loss of coal, great loss of labour and cost of haulage, there are all the other attendant evils of a wasteful system. In money loss, the cost of cartage of the coal wasted in our domestic fires alone, taking the basis of the figures already given, amounts to £268,750* annually, while the unnecessary passage of about a million and a half of horses through the streets to draw this wasted coal, adds very seriously to the cost of street cleansing and repairing. To this should be added the cost of taking away ashes (20 per cent. of cinders is a low estimate) from the wasted coal, which amounts to £43,000 a year. I give these figures as approximate and estimated calculations, having a certain value in reference to the obvious objection that the cost of adopting grates or furnaces of a smoke-abating type is an unreasonable objection from the economic point of view.

Obviously there is nothing substantial in the objection as to the smallness of the waste, which has sometimes been put forward, inasmuch as overwhelming evidence proves that where black smoke is seen, combustible gases of greater heating value than the percentage of carbon in the smoke are also present, and moreover the measure of waste does not consist in the value of the combustible constituents of the smoke, but very largely in the heat which escapes unutilised from the defective method of conducting combustion, of which smoke is the visible sign, and secondarily in the damage which the smoke itself causes to property of various kinds.

* 2*s.* 6*d.* per ton on 215,200 tons.

Another set of objectors urge that to prevent smoke in our towns would be to remove a valuable antiseptic agent, the soot. Mr. J. G. Romanes, F.R.S., speaking at a meeting held at Grosvenor House, said on this subject, "It had been said, and it was quite true, that carbon was antiseptic in some relations; but it would be absurd to suppose that it was antiseptic in all its relations. There could be no doubt that if they were to exclude smoke from our towns altogether, they would increase the longevity of the inhabitants. He thought there were many present who, like himself, would be shortly glad to exchange the town for the country, and feel no regret at leaving the smoke, with all its antiseptic influences, behind them."

It has been said by some that in suppressing smoke we deprive ourselves of one of the most powerful disinfectants, and thereby nourish disease in our over-crowded cities, but as a matter of fact, infectious diseases have been proved by the statistical evidence, of which I shall here adduce a summary,* to be more prevalent, in proportion, in large manufacturing towns, where smoke abounds, than in country towns and rural districts.

In fact, the medical evidence as to the deleterious character of smoke is very emphatic, and has completely changed the aspect of things from the point of view of the public.

Sir Wm. Gull writes to me in a letter which I have had his authority to publish, "It is clear that smoke and fog, not only touch, but kill the life of man." Sir Andrew Clark, Sir Henry Thompson, Sir T. Spencer Wells, Prof. Corfield, Dr. Ransome (of Manchester), and other eminent medical authorities have added their testimony.

Sir Andrew Clark writes to me: "I for my part have no manner of doubt that a smoke-laden atmosphere exercises an injurious influence upon the health, moral as well as physical, of those persons that dwell in the midst of it. A smoky atmosphere, both by its exclusion of light and by the irritating particles suspended in it, is hurtful to the

* See Appendices, pp. 204–211.

lungs and air passages; it aggravates the discomforts of sufferers from heart disease; it deepens the distress of the nervous; it lowers the tone of the general health; it adds perils to the sickness of the aged; and it materially diminishes that brightness and buoyancy of spirits which contribute so much to the power and the gladness of life."

Dr. Dudfield, President of the Society of Medical Officers of Health, in his last annual report on the health of Kensington, remarks: "The mortality would have been less than it was, had it not been for the contaminated and occasionally poisonous condition of the atmosphere—poisoned not by the 'disease germs,' on which so much has been said of late years, but by irritating and devitalising London smoke, the deleteriousness of which will increase with the growth of the metropolis, until measures are taken to abate the augmenting nuisance and danger. This was forcibly illustrated by the returns for last February. We were then the victims of fogs of unusual density, offensiveness, and duration, and the deaths in London from diseases of the respiratory organs were concomitantly 746 above the average. That is to say, in that month alone nearly 1,000 people died of smoky chimneys—for that to these the fogs are due is doubted by no competent person. The effects of the same pernicious cause were manifested also in other ways. Four of the zymotic diseases in Kensington, which are specially liable to be fatal from chest complications, or specially affect the organs of respiration were above the average." Scarlet fever killed 58, as against an average of 57; measles 77, as against 73; and whooping cough 119, as against 99; and diphtheria was registered as the cause of 25 deaths within the limits of the parish, the decennial average being only 20. The other deaths from diseases of the chest were, again, 91 more than in the previous year. "They are always more fatal," observes Dr. Dudfield, "when fog, especially London fog, is associated with cold."

During the five years, 1868-73, the average death-rate from diseases of the respiratory organs was 2·27 per 1,000

in Westmoreland (one of the healthiest counties in England) and 2·51 in North Wales.

For the whole of England and Wales it was 3·54; for Salford, 5·12; and for the Registration district of Manchester, 6·10. Taking, however, the township of Manchester alone, it appears that in 1874, the last for which returns have been published by the Registrar-General, the death-rate from these diseases amounted to 7·7 or three times the average of healthy districts, and more than double the general average for town and country districts—healthy and unhealthy. If, therefore, the rate could be reduced to the average for all England, there would be an annual saving of more than 700 lives in Manchester alone.

In 1873 the deaths in Westmoreland from diseases of the respiratory organs were 13·7 per cent. of the total deaths from all causes; in North Wales also 13·7 per cent.; in all England and Wales 17·2 per cent.; in Birmingham, 18·2: in Liverpool, 18·7; in Sheffield, 21·0; and in Manchester, 21·6 per cent.; but excluding the out townships, the rates in the township of Manchester alone amounted to 23·2 per cent. It appears, therefore, that Manchester suffers more from diseases of respiratory organs than any other town or city in England; and it may be safely affirmed that if no means can be found of reducing the number of deaths from this class of diseases, it is hopeless to expect that any material improvement can be made in the general state of the public health, or any sensible reduction effected in the general death-rate of the city. (*Extract from Manchester and Salford Sanitary Association Report.*)

All authorities who have investigated the question are agreed that, in the case of manufacturers, future legislation should deal with the sulphurous acid given off as from the combustion of coal in large furnaces, as a noxious vapour, and that a large part of the injury done to vegetation and to public buildings in the neighbourhood of such factories is due to the production of sulphurous acid. A good deal of the coal used contains 2 per cent. of sulphur, and if all

smoke was rendered invisible by complete combustion there would still remain sulphuric acid to do its damage, which, although probably not great in the case of dwelling-houses, where the smoke is so much diluted, is undoubtedly very considerable from large factories. (See *Sanitary Record*, vol. ix. p. 345).

This is a question which concerns manufacturing towns especially. It is satisfactory to know, however, that the experiments of Mr. Estcourt, Analyst to the City of Manchester, and of Mr. F. F. Goodfellow, have proved beyond doubt that it is possible to free coal smoke emitted by works, etc., from blacks and acid gas vapours at a cost within reasonable bounds. A full description of this machine or smoke-condenser will be found, by Mr. Estcourt, in the *Sanitary Record* of September 15th, 1879. It is now, I believe, actually working at Hyde in connection with the furnaces of two boilers consuming about fifty tons of coal per week.

Some doubts have been expressed as to the effects which might be expected upon the mortality from zymotic diseases, if London were deprived of what some over-wise philosophers appear to consider as the antiseptic influence of creosote products of smoke on the atmosphere. I have, with the kind assistance of Mr. Humphrey, taken out from the mortality records comparative abstracts of the mortality from zymotic diseases in London, and in selected smoky districts during the last year, and compared these with each other and with the mortality of the rural districts, with striking results. (See Appendices, pp. 204–211.)

It has further been urged that it is visionary to attempt to deal with domestic chimneys, as the Englishman is inclined to look upon his house as his castle, in which he will not tolerate interference.

The obvious reply to this argument is, that though a man can hardly be prevented from poisoning himself by an excessive production of smoke, if he chooses to allow his chimneys to smoke downwards into his own apartments, he can have no right either legally or morally to poison the

atmosphere inhaled by those who have the misfortune to live in close proximity to him. Such an argument is indeed quite fallacious in view of the many restrictions under which he is put, both as regards the construction of his walls and his sewers, and in respect of infectious disease occurring in his household, and other matters which no less affect his neighbours than himself.

It may be added that his present liabilities to the community are pecuniarily far more onerous than any which would be imposed by the adoption of one of the many means for securing an abatement of smoke.

I now come to the second head, and will endeavour to trace the steps which have been recently taken in collecting evidence as to the extent to which the evil exists and the possibility of abating it, and to indicate the individual efforts which appear to be demanded by the evidence adduced. In the first place I wish to call your attention to the result of the tests as published in the Official Report of the Smoke Abatement Committee, which show that with gas, coke, and anthracite coal it is easy to cook and heat efficiently and economically and prevent smoke *absolutely*. But taking domestic open grates suited to our existing fireplaces using what is called Wallsend coal, it is shown that some grates produce six times more smoke than others do, and burn three times more coal to do equal work.* The same report shows that steam boilers and other furnaces may be worked absolutely without smoke, and that the average of efficiency of steam boilers tested ranged between 30 per cent. and 76 per cent. of the coal consumed, and in the tests of different coals in the same furnace, the evaporative efficiences ranged between 6·84 and 12·25, or a variation of 55·7 per cent., thus proving the great necessity which

* Marked improvement has, however, been made in open grates and stoves for burning this description of coal, and one firm of manufacturers, who brought out a cheap stove at the South Kensington Exhibition, sent a report to the Council showing that they have sold upwards of 14,000 during the past two years; and they remark that the public seem ready to burn non-smoky coal if proper stoves for using it are offered at a reasonable price.

exists for selection of coal as well as selection of furnaces.

Of the trades carried on in the metropolis in which at the present time smoke is being abated those trades which use steam boilers stand highest. The potters, iron founders, smiths, steam vessels and bakers, in individual cases, abate smoke entirely or keep it within very reasonable limits. And what individuals can do, the whole trade can do. But in general all these trades fall far short of what might fairly be done to stop smoke, which should no longer be called a nuisance but a national evil and a national disgrace.

The trades which appear by the Returns of Smoke Nuisances to produce the most smoke in the metropolis are the bakers, brewers, builders, chemical works, confectioners and pastry cooks, iron and brass founders, laundries, leather dressers, oilworks, potters, printers, sawmills, smiths, steam boats and tanners. Now in each of these classes, individual cases may be cited to show that trade can be carried on without any or with but little production of smoke. As evidence of this, a deputation recently waited upon us at a meeting of the Council of the Smoke Abatement Institution, and communications were received from various persons representing the following trades:—bread-bakers; japanning and lacquering; tile and porcelain firing; glass-staining and bending; carbon preparation for various purposes; furnace builders; confectioners; restaurant keepers and refreshment contractors; coke manufacturers; gas engine manufacturers; scientific instrument manufacturers, and others, to inform the Council that smoke-preventing appliances had been widely adopted with satisfactory results.

After the holding of the Smoke Abatement Exhibition, which has effected such useful results and furnished so much available information, the Committee took measures for creating an institution which would be fitted for carrying on the movement in an organised manner, and the present National Smoke Abatement Institution was established,

the deed of incorporation of which was signed by the Dukes of Northumberland and Westminster, Lord Mount Temple, Sir Lyon Playfair, Sir Frederick Pollock, Sir H. Hussey Vivian, and Mr. Ernest Hart on behalf of the Committee. The Institution was sanctioned by the Board of Trade in order to extend and carry on in a more organised manner the work previously carried on by the Smoke Abatement Committee of London and Manchester.

Last year's Report, which was submitted to a public meeting held at the Mansion House, included the result of the Council's enquiry into the working of the Smoke Acts in London, and the changes in heating methods which are gradually being introduced.

The results achieved are well summarised in the Report of the Committee presented at the Mansion House last week. It states that:—

In regard to the extended influence of the subject upon public opinion, it is to be noticed that in Manchester, Sheffield, Glasgow, Birmingham, Leeds, Preston, Salford Liverpool, and Newcastle, as well as numerous smaller places where the publications of the Institution have been freely circulated, the necessity for abating smoke has been generally recognised, and the subject is now one of active public discussion in the press and elsewhere. Strong appeals have been made to the local authorities to enforce the law, with successful results in many instances.

Medical opinion has been expressed with marked emphasis during the year, and fully bears out the view to which reference has already been made.

With regard to the changes in heating systems alluded to in the Council's Report submitted last year at the Mansion House, the Council are glad to be able now to announce that many of the changes referred to as being then only in prospect, or in a tentative state, have since become thoroughly established, with the most beneficial results,—notably the application of gaseous fuel to the heating of bakers' ovens. Since last year some of the largest bakeries have adopted the improved gas-heated

and other modified furnaces, and are now worked without producing any smoke whatever, and are turning out large quantities of bread prepared and baked under conditions which are more cleanly as well as more healthy to the operatives employed than were attainable when the old style of smoke-producing furnaces were used. Of this examples are exhibited in action in the working bakeries at the present Health Exhibition, which have been watched with much interest, and I hope profit, by vast numbers of people. This is one immediate outcome of the Smoke Abatement Exhibition of 1881.

It is stated that the number of gas engines in London had increased very rapidly within the past three years, and the total number now at work is estimated at upwards of 6,000, and thus a considerable quantity of smoke has been prevented by their use.

Several open domestic fire grates of modified form have been introduced into use during the past year, and the Council are glad to find that open grates now manufactured are generally improved by being shallower from front to back, and modified in the form of the bars and back, and by being lined with fire-brick, as well as in other points of detail, so as to render them more economical, and considerably less smoke producing. "Blowers," "radiators," and appliances of various patterns for ordinary open grates, have been introduced, and some of these have proved effective in reducing smoke and saving coal. While heating by open grates so largely prevails, any improvements in them must be considered particularly satisfactory. Corresponding improvements are observable in some of the modern forms of kitcheners. I may add that in my own house I have by a very cheap and simple modification of an old-fashioned large and unwieldy kitchener, on the principal of the Luton kitcheners of Messrs. Brown and Green, made it smoke-consuming with ordinary fuel, so that it is more efficient and economical in use. And for nearly two years the chimney has been smokeless, and during the whole of that time it has not

needed to be swept. My cook, too, is entirely satisfied with it.

Coke is now delivered by the chief gas companies broken into suitable size for burning alone or mixed with ordinary coal—a very important and economical means of heating with but little production of smoke. Fire-brick or other slow-conducting material is being increasingly used in modern grates instead of iron, and advancing knowledge has tended to considerably increase the use of coke for domestic purposes, under conditions compatible with free ventilation, and in no way adverse to health. Various simple arrangements of gas jets on the system introduced by the late Sir William Siemens for lighting coke, or urging the fire, when it requires to be suddenly increased, have been brought out recently, and have extended the use of these convenient and smokeless open fires.

The cooking apparatus for large as well as small establishments have been very materially improved. At the Draper's Hall, in the City, as well as at various other places in the Metropolis, kitchens entirely smokeless have been substituted for smoky ones; and in view of this fact the Council call the special attention of the authorities to the necessity for repressing smoke from the club-houses and hotels, restaurants, dining-rooms, and the like, which now needlessly produce it in very large quantities.

The improvements noticed last year in the manufacture of coke have been widely applied since, and various methods for recovering and utilising the volatile constituents of coal which are still largely dispersed into the atmosphere as constituents of "smoke" have been further perfected and applied. By one of these methods small coal, hitherto an entirely waste product in most districts, is converted into an excellent fuel for domestic purposes, which is cheap and entirely smokeless, while by-products are recovered, worth at present prices fully 2*s.* per ton of coal treated, after providing for the cost of the process.

An extensive series of tests of gas stoves and grates, gas boilers, gas regulators, and other gas appliances, have

been conducted for the Gas Committee of the recent Crystal Palace Exhibition, who retained the services of the Testing Engineer of the Smoke Abatement Institution, Mr. D. K. Clark, for the purpose, (see *Sanitary Record* for April 15, 1883). Awards have been made on the results of the tests by a jury of gas experts. The results of the experimental investigations led to many new and important deductions, considerably modifying, and in some respects reversing, generally received opinion. It was proved that under 20 per cent. of the heat generated in gas *cooking* stoves is directly utilised in roasting a joint, while, on the contrary, in gas-*heating* stoves of the best construction the proportion of heat utilised under favourable working conditions for heating the apartment reached upwards of 90 per cent. The report of these tests, which were of a complete and exhaustive character, is now in the press, and shows generally that marked improvements have been made, both in gas-cooking and gas-heating stoves, and that they must tend greatly to encourage the use of these stoves in preference to coal fires. Among the heating and smoke-abating apparatus now being exhibited at the present Health Exhibition, are many modifications of apparatus exhibited at South Kensington in 1881, and, as a member of the Executive Council of the present Exhibition, I am glad to be able to state that a valuable series of tests are now being made, in virtue of a grant of money which we have made for the purpose of defraying the expenses of such tests, under the direction of the Jury of the Exhibition, for the purpose of ascertaining the merits of new inventions, and the precise value of the changes which have been made, and in virtue of the arrangements made, the new series of tests will be uniform in character, and comparable with those attained at the previous exhibition. At my instance a decree was made at the outset of the Exhibition that the boilers needed for the production of motor power should be smokeless.

The Council of the Smoke Abatement Institute

consider the testing of new or modified apparatus as a most important and useful branch of the work of the Institution, and one of which they anticipate the public will further avail itself as time goes on. It is difficult for inventors and manufacturers to obtain satisfactory and impartial tests of their apparatus, and therefore they may be expected to avail themselves in increasing numbers of the facilities offered by the Institution; while on the other hand the public are at a disadvantage in judging of the character of modified systems, and the relative efficiency of new apparatus, in the absence of some system of independent tests. The stimulus given by competitive testing is very marked and beneficial. Even during the course of recent investigations, several cases of inventors modifying their apparatus and coming up for a second test have occurred, and, in the case of apparatus for using gas and coke for heating purposes, it may be mentioned that the newer forms of stoves are fully 20 per cent. superior in efficiency and economy to those of three years back.

Numerous lectures on cooking and heating, initiated by various persons interested in the smoke-abatement movement, have been given in various parts of London and the provinces, and at the Building Trades and Sanitary Exhibitions held in London, and in almost all the chief towns during the year, and it is particularly noticeable that heating and smoke-preventing apparatus has been shown as a separate and important branch of these Exhibitions.

The uses of smokeless coals and coke for heating purposes, both domestic and industrial, have increased considerably during the past year, and the system of heating houses uniformly by hot-water pipes has also increased as the direct result of the improvements made in the apparatus.

The use of producer-gas has much developed since the Smoke Abatement Exhibition, at South Kensington, and since that time it is satisfactory to find that many applications of gas-producers have been made in different

parts of the country, many leading firms have sent orders for additional producers after experience of their working. For boiler firing to char-kilns, for heating furnaces, annealing furnaces, brick, tile, and other furnaces, producer-gas has been successfully applied.

From the communications received from many places abroad, as well as from all parts of the United Kingdom, the Council express themselves satisfied that, on the one hand, the desire to abate the smoke of towns is fast increasing, and, on the other hand, the means of accomplishing that object have generally improved in kind and increased in variety.

During the year, the Council have arranged, as contemplated by their last Report, for heating and smoke-abating apparatus to be shown at the Parkes Museum. The collection will be added to, and changed from time to time, in order to be made as useful as possible to persons who have apparatus to bring into notice, and those who are in want of such articles. The Council hope the public will avail themselves of the facilities afforded by the Museum. No charge is made for exhibiting the articles, and the address of the exhibitor is attached to each.

A Bill to amend the Acts relating to smoke from the furnaces and fireplaces within the Metropolis has recently been introduced into the House of Lords by Lord Stratheden and Campbell. It contains provisions for the supervision and control of the heating arrangements of all *new buildings*, including dwelling-houses, in order that smoke from them may be minimised. The Bill further provides for local authorities being empowered to create, subject to the approval of the Home Secretary, bye-laws for the restraint of smoke in their respective districts, as well as to extend the provisions of the Smoke Abatement (Metropolis Acts) to the whole of the Metropolitan police area, and to include under the provisions of those Acts all the trades and furnaces which are not at present included.

It is stated in the last Report of the Smoke Abatement Institution (see *Sanitary Record* for June 16, 1884), the

Council consider the progress made during the past year to have been in many respects satisfactory and encouraging. They, however, deem it essential that legislation should be advanced *pari passu* with the voluntary efforts which are being put forth. As regards London, it is obviously necessary that the area now covered by the Smoke Abatement Acts should be extended, that all the trades which do not at present come within the operation of the Acts should be included, and further, that the smoke of steamers on the river, which is now enormous and practically unchecked, should be brought under control, and the smoke from locomotive engines on the railways throughout the Metropolis should also be restrained. We shall all hope that these changes, as well as the regulation of the heating of new buildings, including dwelling houses, will receive the immediate attention of the legislature and the public.

Until the Smoke Abatement Committee was formed and a centre was established to which general interest in the subject could converge, the public were never adequately informed of the extent of the evil nor aroused to the necessity for concerted effort to abate it. No machinery by which the evil could be seriously grappled with had been provided, but in saying this, I do not disparage the efforts of those who have gone before, who are entitled to be considered as pioneers. They warned us against the evils of smoke, and even in some cases provided means for avoiding it to a great extent. The legislation which they initiated had the effect of reducing the smoke of certain districts, yet in spite of individual and isolated efforts, the excessive production of smoke has increased, growing with the growth of our cities, and the strides of our industrial progress. Self interest has, it must be borne in mind, done much within the last three or four years to check the evil, as was recently stated at Glasgow.

The future progress of the cause must depend mainly on the extent to which the public interest is awakened to recognition of the necessity and desirability of change, and on the choice of the time at which this influence is brought

to bear. If public support is prompt in encouraging and extending the movement now in active existence, scientific ingenuity and commercial interests will naturally be stimulated to continue efforts in an increasing ratio to supply public demand.

It is only by enlisting general public interest, now fairly awakened by the smoke-abatement movement, that present results have been attained, and we may now, without incurring the ridicule which at first attached to our efforts, reasonably indulge the hope of ultimate success in abolishing a smoke-laden atmosphere. I would quote the eloquent words of Sir Frederic Leighton, who said at the Mansion House, "If each individual would say, 'My fireplace shall smoke no longer,' the millenium would have come." The means exist and are accessible to all, and I am satisfied that London is now sensibly less smoky than when we began to work.

In conclusion, I may say that I do not believe that the Bill which has been brought in by Lord Stratheden and Campbell is destined to very serious consideration at present in Parliament, because it has been brought in under circumstances which, highly honourable as they are to the noble lord who has introduced the Bill, are not the circumstances under which an important measure of this sort ought to be brought in. It has not been brought in with the active aid of the leaders of any party, or with the assistance which we had a right to expect of the Home Office; and at the present time, valuable as is the proposed Bill for eliciting public opinion, I fear that it is powerless as regards legislation.* We must look to the leaders and people, to those who are in authority and power, not to allow a measure of this sort to be bandied about in the House as a measure in which they have no interest, in the manner in which the House is apt to deal with mere crotchets that can be delayed from year to year. We claim for the measure of Lord Stratheden and Campbell official recognition by

* Subsequent to the printing of these pages the Bill was read a second time.

the Government, and we claim for it a reference to a Select Committee or to a Royal Commission which shall impartially investigate the facts that we can place before the Committee. We have arrived at a stage when, as we say, great progress has been made and great possibilities are open, and we ask for an official investigation into the statements made—not alone by myself, but by a committee including the official adviser of the Government at the Royal Mint, the Lecturer on Metallurgy, and the great master of the science of combustion in this country, Professor Chandler Roberts, and on statements made by Mr. Kinnear Clark, and by Captain Douglas Galton, as well as by Dr. Frankland, and other high scientific authorities. All I have tried this evening to do, I know very imperfectly, but I hope earnestly, has been to promote a great public cause, which up to the present has been wholly carried on by private effort. We shall continue to carry the cause, on though there are limits beyond which unaided private enterprise should not be solely relied upon. We believe that we have now reached that limit and that Government should step in to help us to solve this important question, and to give effect to the reforms which have been achieved.

A vote of thanks was accorded to Mr. Ernest Hart for his able lecture, and for his great services in initiating the Smoke Abatement movement and promoting its progress; and also to the Chairman for presiding.

APPENDIX I.

MORTALITY STATISTICS FOR LONDON AND FOUR GROUPS OF MANUFACTURING AND ONE OF RURAL DISTRICTS. 1880.

Groups of Districts.	Enumerated Population, 1881.	Deaths (All causes).	Deaths from Principal Zymotic Diseases.	Small-pox.	Measles.	Scarlet Fever.	Diph-theria.	Whooping Cough.	Fever.	Diarrhœal Diseases.	Deaths of Children under 1 year to 1000 births.
London	3,814,571	81,832	13,933	471	1521	3100	544	3516	910	3871	158
		21·5	3·65	0·12	0·40	0·81	0·14	0·92	0·24	1·02	
Aggregate of Groups I.–IV. .	2,784,169	60,920	11,209	27	1146	2136	205	1437	1374	4884	171
		21·9	4·03	0·01	0·41	0·77	0·07	0·52	0·49	1·76	
Group I. :—											
Wolstanton.	179,762	4289	762	1	81	52	26	108	76	418	199
Stoke-on-Trent		23·9	4·24	0·00	0·45	0·29	0·14	0·60	0·42	2·34	
Group II. :—											
Wolverhampton	495,959	10,048	1786	..	134	387	35	243	187	800	162
Walsall		20·3	3·60	0·00	0·27	0·78	0·07	0·49	0·38	1·61	
West Bromwich											
Dudley											

Group III. :—											
Prescot Ormskirk Wigan Warrington Leigh Bolton Bury Blackburn Chorley Preston	1,142,413	25,912 22·7	5417 4·74	23 0·02	592 0·52	1076 0·94	90 0·08	732 0·64	592 0·52	2312 2·02	174
Group IV. :—											
Huddersfield Halifax Bradford Hunslet Holbeck Bramley Leeds	966,035	20,671 21·4	3244 3·36	3 0·00	339 0·35	621 0·64	54 0·06	354 0·37	519 0·54	1354 1·40	166
Group V. (Rural)											
Counties of Wilts, Dorset, and Devon, exclusive of Town Districts of Devizes, Salisbury, Weymouth, Exeter, and Plymouth.	804,764	14,226 17·7	1596 1·98	1 0·00	439 0·55	230 0·29	51 0·06	262 0·33	202 0·25	411 0·50	115

APPENDIX II.

MORTALITY STATISTICS FOR LONDON AND FOUR GROUPS OF MANUFACTURING AND ONE OF RURAL DISTRICTS. 1866 (CHOLERA YEAR).

Groups of Districts.	Estimated Population, 1866.	Deaths (All causes).	Deaths from Principal Zymotic Diseases.	Small-pox.	Measles.	Scarlet Fever.	Diphtheria.	Whooping Cough.	Fever.	Diarrhœal Diseases.	Deaths of Children under 1 year to 1000 births.
London	3,029,125	80,453	20,503	1391	2220	1892	462	2960	2688	8890	174
		26·6	6·77	0·46	0·73	0·62	0·15	0·98	0·89	2·94	
Aggregate of Groups I.–IV.	2,187,268	59,557	12,520	274	1768	1896	315	1975	2986	3306	195
		27·2	5·72	0·13	0·81	0·87	0·14	0·90	1·37	1·50	
Group I. :—											
Wolstanton Stoke-on-Trent	141,929	4537	1101	88	105	293	66	96	194	259	215
		32·0	7·76	0·62	0·74	2·06	0·47	0·68	1·37	1·82	
Group II. :—											
Wolverhampton Walsall West Bromwich Dudley	429,098	10,833	2226	5	245	294	65	566	521	530	187
		25·2	5·19	0·01	0·57	0·69	0·15	1·32	1·21	1·24	

Group III. :—											
Prescot, Ormskirk, Wigan, Warrington, Leigh, Bolton, Bury, Blackburn, Chorley, Preston	864,670	23,947 27·7	5554 6·42	115 0·13	744 0·86	1004 1·16	101 0·12	723 0·84	1234 1·43	1633 1·88	192
Group IV. :—											
Huddersfield, Halifax, Bradford, Hunslet, Holbeck, Bramley, Leeds	751,571	20,240 26·9	3639 4·84	66 0·09	674 0·90	305 0·41	83 0·11	590 0·79	1037 1·37	884 1·17	200
Group V. (Rural).											
Counties of Wilts, Dorset, and Devon, exclusive of Town Districts of Devizes, Salisbury, Weymouth, Exeter, and Plymouth.	799,543	15,927 19·9	2305 2·88	20 0·03	258 0·32	392 0·49	90 0·11	356 0·45	473 0·59	716 0·89	113

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Counties of Wilts, Dorset, and Devon, exclusive of Town Districts of Devizes, Salisbury, Weymouth, Exeter, and Plymouth.	799,543	15,927 19·9	2305 2·88	20 0·03	258 0·32	392 0·49	90 0·11	356 0·45	473 0·59	716 0·89	113

These tables may be read as follows:—

No. 1. *Mortality Statistics for London and Four Groups of Manufacturing and One of Rural Districts for* 1880.—London, with an enumerated population of 3,814,571, showed the deaths from all causes to be 81,832, being an average of 21·5. The deaths from the principal zymotic diseases were 13,933, being an average of 3·65; from small-pox, 471, an average of 0·12; from measles, 1,521, an average of 0·40; from scarlet fever, 3·100, an average of 0·81; from diphtheria, 544, an average of 0·14; from whooping-cough, 3,516, an average of 0·92; from fever, 910, an average of 0·24; from diarrhœal diseases, 3,871, an average of 1·02. The deaths of children under one year averaged 158 per 1,000 births.

The mortality of an aggregate of four groups of northern towns is, in the aggregate, as follows:—Out of an enumerated population of 2,784,169, the deaths from all causes were 60,920, being an average of 21·9 per 1,000. The deaths from the principal zymotic diseases were 11,209, being 4·03 per 1,000; from small-pox, 27, or 0·01 per 1,000; from measles, 1,146, being 0·41 per 1,000; from scarlet fever, 2,136, being 0·77 per 1,000; from diphtheria, 205, 0·07 per 1,000; from whooping-cough, 1,437, 0·52 per 1,000; from fever, 1,374, or 0·49 per 1,000; from diarrhœal diseases, 4,884, being 1·76 per 1,000. The deaths of children under one year amounted to 171 to each 1,000 births. An analysis of this aggregate of groups gives the following results:—

Group I., comprising Wolstanton and Stoke-on-Trent, with an enumerated population of 179,762, shows deaths from all causes 4,289, an average of 23·9 per 1,000; deaths from principal zymotic diseases, 762, average 4·24 per 1,000; measles, 81, or 0·45 per 1,000; scarlet fever, 52, 0·29 per 1,000; diphtheria, 26, or 0·14 per 1,000; whooping-cough, 108, or 0·60 per 1,000; fever, 76 cases, 0·42 per 1,000; diarrhœal diseases, 418, 2·34 per 1,000. Deaths of children under one year, 199 out of each 1,000 births.

Group II., comprising Wolverhampton, Walsall, West Bromwich, and Dudley, with an enumerated population of 495,959, shows deaths from all causes 10,048, being an average of 20·3 per 1,000; deaths from principal zymotic diseases, 1,786, average, 3·60 per 1,000; measles, 134, average, 0·27 per 1,000; scarlet fever, 387, average, 0·78 per 1,000; diphtheria, 35, average, 0·07 per 1,000; whooping-cough, 243, or 0·49 per 1,000; fever, 187, or 0·38 per 1,000; diarrhœal diseases, 800, or 1·61 per

1,000. Deaths of children under one year of age, 162 per 1,000 births.

Group III., comprising Prescot, Ormskirk, Wigan, Warrington, Leigh, Bolton, Bury, Blackburn, Chorley, and Preston, with an enumerated population of 1,142,413, shows deaths from all causes 25,912, average death-rate, 22·7 per 1,000; deaths from principal zymotic diseases, 5,417, average death-rate, 4·74; small-pox, 23, average death-rate, 0·02; measles, 592, average death-rate, 0·52 per 1,000; scarlet fever, 1,076, average death-rate, 0·94; diphtheria, 90, average death-rate, 0·08; whooping-cough, 732, average death-rate, 0·64; fever, 592, death-rate, 0·52 per 1,000; diarrhœal diseases, 2,312, average death-rate, 2·02. Deaths of children under one year, 174 to each 1,000 births.

Group IV., comprising Huddersfield, Halifax, Bradford, Hunslet, Holbeck, Bramley, and Leeds, with an enumerated population of 966,035, gives the following mortality returns:— Deaths from all causes, 22,671, with an average death-rate of 21·4; deaths from principal zymotic diseases, 3,244, with an average death-rate of 3·36; scarlet fever, 621, with an average death-rate of 0·64; diphtheria, 54, with an average death-rate of 0·06 per 1,000; whooping-cough, 354, with a death-rate of 0·37; fever, 519 deaths, being a death-rate of 0·54 per 1,000; diarrhœal diseases, 1,354, an average death-rate of 1·40 per 1,000. Deaths of children under one year, 166 per 1,000 births.

Next comes Group V., which is a rural group comprising the counties of Wilts, Dorset, and Devon, exclusive of town districts of Devizes, Salisbury, Weymouth, Exeter, and Plymouth, with an enumerated population of 804,764, and shows deaths from all causes 14,226, with an average death-rate of 17·7; deaths from principal zymotic diseases, 1,596, with an average death-rate of 1·98; measles, 439, an average death-rate of 0·55 per 1,000; scarlet fever, 230 deaths, or an average death-rate of 0·29; diphtheria, 51 deaths, average death-rate, 0·06; whooping-cough, 262 deaths, average death-rate, 0·33; fever, 202 deaths, average death-rate, 0·25 per 1,000; diarrhœal diseases, 411, average death-rate, 0·50 per 1,000. Deaths of children under one year of age, 115 per 1,000 births.

I have also the same figures made out for the cholera year of 1866, with the following result:—

No. 2. *Mortality Statistics for London, and Four Groups of Manufacturing and One of Rural Districts, during the Cholera Year of* 1866.—In London, with an estimated population for 1866 of

3,029,125, we find the deaths from all causes to be 80,453, an average death-rate of 26·6 per 1,000. The deaths from the principal zymotic diseases were 20,503, being an average rate of 6·77 per 1,000. Deaths from small-pox, 1,391, average rate, 0·46; measles, deaths, 2,220, death-rate per 1,000, 0·73; scarlet-fever, deaths, 1,892, rate per 1,000, 0·62; diphtheria, 462 deaths, death-rate per 1,000, 0·10; whooping-cough, deaths, 2,960, death-rate per 1,000, 0·98; fever, 2,688, death-rate, 0·89 per 1,000; diarrhœal diseases, 8,890, death-rate per 1,000, 2·94. Deaths of children under one year, 174 to each 1,000 births. We then have an aggregate of the mortality of the same manufacturing districts as in the set of tables No. 1. The aggregate of the estimated population in these four groups was 2,187,268; the deaths from all causes, 59,557, with a death-rate of 27·2 per 1,000. The deaths from the principal zymotic diseases in this group of four districts amounted to 12,250, the death-rate being 5·72 per 1,000; the deaths from small-pox were 274, the death-rate 0·13 per 1,000; from measles the deaths were 1,768, death-rate 0·81 per 1,000; scarlet-fever reckoned 1,896, with an average death-rate of 0·87 per 1,000; diphtheria reckons 315 deaths, with a death-rate of 0·14 per 1,000; whooping-cough, 1,975 deaths, death-rate 0·90 per 1,000; fever, 2,986 deaths, death-rate 1·37 per 1,000; diarrhœal diseases, 3,306, death-rate 1·50 per 1,000. Deaths of children under one year, 195 deaths per 1,000 births. An analysis of these groups gives the following results:—

Group I., comprehending Wolstanton and Stoke-upon-Trent, with an estimated population of 141,929, gives 4,537 deaths from all causes, or a death-rate of 32·0 per 1,000. Deaths from principal zymotic diseases were 1,101, a death-rate of 7·76; from small-pox, 88, a death-rate of 0·62; from measles, 105, a death-rate of 0·74; scarlet fever, 293, a death-rate of 2·06; diphtheria, 66 cases, an average death-rate of 0·47; whooping-cough, 96, average death-rate, 0·68; fever, deaths, 194, death-rate, 1·37; diarrhœal diseases, 259 deaths, average death-rate, 1·82. Deaths of children under one year, 215 deaths per 1,000 births.

Group II., comprising Wolverhampton, Walsall, West Bromwich, and Dudley, of which the estimated population is 429,098; the deaths from all causes 10,833, average death-rate, 25·2 per 1,000. Deaths from all principal zymotic diseases, 2,226, average death-rate, 5·19; measles, deaths, 245, average death-rate, 0·57; scarlet-fever, 294, death-rate, 0·69; diphtheria, 65, death-rate

0·15; whooping-cough, deaths, 566, death-rate, 1·32; fever, deaths, 521, death-rate, 1·21; diarrhœal diseases, deaths, 530, death-rate, 1·24. Deaths of children under one year, 187 deaths to every 1,000 births.

Group III., comprising Prescot, Ormskirk, Wigan, Warrington, Leigh, Bolton, Bury, Blackburn, Chorley, and Preston, with an estimated population of 864,670, affords statistics giving deaths from all causes, 23,947, a death-rate of 27·7 per 1,000. Deaths from principal zymotic diseases, 5,554, with a death-rate of 6·42; small-pox, 115 cases, death-rate, 0·13; measles, deaths, 744, death-rate, 0·86; scarlet-fever, deaths, 1,004, death-rate, 1·16; diphtheria, 101 deaths, death-rate, 0·12; whooping-cough, 723 deaths, death-rate, 0·84; fever, 1,234 deaths, death-rate, 1·43; diarrhœal diseases, 1,633, death-rate, 1·88. Deaths of children under one year, 192 per 1,000 births.

Group IV., comprising Huddersfield, Halifax, Bradford, Hunslet, Holbeck, Bramley, and Leeds, with an estimated population of 751,571, gives in this cholera year of 1866, registered deaths from all causes, 20,240, with a death-rate of 26·9 per 1,000. Deaths from principal zymotic diseases, 3,639, death-rate, 4·84; small-pox, 66 deaths, death-rate, 0·09; measles, 674 deaths, death-rate, 0·90; scarlet-fever, deaths, 305, death-rate, 0·41; diphtheria, 83 deaths, death-rate, 0·11; whooping-cough, deaths, 590, death-rate, 0·79; fever, 1,037 deaths, death-rate, 1·37; and diarrhœal diseases, deaths, 884, death-rate, 1·17. The deaths of children under one year of age amounted to 200 per 1,000 births.

Group V., which comprises the rural counties of Wilts, Dorset, and Devon, exclusive of the town districts of Devizes, Salisbury, Weymouth, Exeter, and Plymouth, with an estimated population of 799,543, shows deaths from all causes, 15,927, death-rate, 19·9; deaths from principal zymotic diseases, 2,305, average death-rate, 2·88; small-pox, deaths, 20, death-rate, 0·03; measles, 258, death-rate, 0·32; scarlet-fever, 392 cases, death-rate, 0·49; diphtheria, deaths, 90, death-rate, 0·11; whooping-cough, 356 deaths, death-rate, 0·45; fever, 473 deaths, death-rate, 0·59; diarrhœal diseases, 716 deaths, death-rate, 0·89. The deaths of children under one year of age was 113 to every 1,000 births.

APPENDIX III.

SMOKE NUISANCE ABATEMENT (METROPOLIS). [H.L.]

47 & 48 VICT.

A BILL intituled An Act to amend the Acts for abating the Nuisance arising from the Smoke of Furnaces and Fireplaces within the Metropolis.

WHEREAS by an Act passed in the Session of Parliament held in the sixteenth and seventeenth years of the reign of Her present Majesty, intituled "An Act to abate the Nuisance arising from the Smoke of Furnaces in the Metropolis and from Steam Vessels above London Bridge" (16 & 17 Vict. c. 128) (in this Act referred to as "the Act of 1853"), and by a further Act passed in the session of Parliament held in the nineteenth and twentieth years of the reign of Her present Majesty, intituled "An Act to amend the Smoke Nuisance Abatement (Metropolis) Act, 1853" (19 & 20 Vict. c. 107) (in this Act referred to as "the Act of 1856"), and by the Sanitary Act, 1866 (29 & 30 Vict. c. 90), provisions have from time to time been made for abating the nuisance arising from the smoke of furnaces and fireplaces within the metropolis, but the said provisions have not been effectual in abating the same; and it is expedient that further provision should be made in relation thereto:

Be it therefore enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows; that is to say,

1. *Short Title.*—This Act may be cited for all purposes as the Smoke Nuisance Abatement (Metropolis) Act, 1884.

2. *Limits of Act.*—This Act shall extend and apply to the

metropolis as defined by the Metropolis Management Act, 1855 (18 & 19 Vict. c. 120).

3. *Interpretation.*—In this Act—

The expression "local authority" means,

As to the city of London and the liberties thereof, the mayor, commonalty, and citizens acting by the Commissioners of Sewers;

As to any parish mentioned in Schedule A. to the Metropolis Management Act, 1855, the vestry;

As to any district mentioned in Schedule B. to the Metropolis Management Act, 1855, the district board; and

The expression "district," used in relation to any local authority, means the area within which such local authority has jurisdiction.

4. *Power for local authorities to make byelaws prohibiting emission of smoke from buildings.*—Any local authority may from time to time make, and when made, alter and repeal byelaws—

For prohibiting or regulating the emission of smoke from any building within their district.

Any such byelaws may exempt buildings below a certain rateable value to be fixed by such byelaws from the operation thereof, or may limit the hours within which such byelaws are to be in force, or may contain any other restrictions and provisions which the local authority may think expedient.

Any local authority may, by any byelaws made by them under this section, impose on offenders against the same such reasonable penalties as they think fit for each offence, and in the case of a continuing offence such further penalty as they think fit for each day after written notice of the offence from the local authority; but all such byelaws imposing any penalty shall be so framed as to allow of the recovery of any sum less than the full amount of the penalty.

No byelaw made in pursuance of this section, or alteration, or repeal thereof, shall be of any validity until it has been confirmed by one of Her Majesty's principal Secretaries of State.

No byelaw made under this section, or alteration or repeal thereof, shall be confirmed by one of Her Majesty's Principal Secretaries of State until the expiration of two months after a copy of the byelaw, together with notice of the intention to apply for confirmation of the same has been published by the local authority, once at least in each of two consecutive weeks in two or more newspapers circulating in the metropolis; and any

person affected by any such proposed byelaw, or alteration or repeal thereof, may forward notice of his objection to such Secretary of State, who shall take the same into consideration.

All bye-laws made and confirmed as aforesaid in pursuance of this section shall be printed and hung up in the principal office of the local authority and be open to public inspection without payment, and copies thereof shall be delivered to any person applying for the same on payment of such sum, not exceeding twopence, as the local authority shall direct; and such byelaws when so published shall be binding upon and be observed by all parties, and shall be sufficient to justify all parties acting under the same, and the production of a printed copy of such byelaws authenticated by the seal of the local authority shall be evidence of the existence and of the due making, confirmation, and publication of such byelaws in all prosecutions under the same without adducing proof of such seal, or of the fact of such confirmation or publication of such byelaws.

Penalties imposed by any such byelaws may be recovered summarily, but no proceedings for the recovery thereof shall be had or taken by any body or person other than the local authority of the district without the consent in writing of the Attorney-General.

5. *Power for Metropolitan Board of Works to make bye-laws as to fireplaces, &c., in new buildings.*—The Metropolitan Board of Works may from time to time make, and when made alter and repeal byelaws. For requiring any fireplace or furnace intended to be used in any building to be constructed after the passing of this Act to be so constructed as to effectually consume or burn, so far as possible, all smoke arising therefrom, and all the provisions of section sixteen of the Metropolis Management and Building Acts Amendment Act, 1878, as to the making, contents, confirmation, publication, evidence, enforcement, alteration, and repeal of byelaws made under that Act, and otherwise in relation thereto, shall extend and apply to byelaws made, altered, or repealed under this section, and have effect accordingly.

6. *Amendment of the Acts of* 1853 *and* 1856.—From and after the passing of this Act section six of the Act of 1853 shall be and the same is hereby repealed, and the said Act and the Act of 1856 shall be read and construed as though the expression "metropolis" in the said Acts meant the metropolis as defined by the Metropolis Management Act, 1855, together with the parish of Willesden.

7. *Amendment of s.* 19 *of Sanitary Act,* 1866.—From and after the passing of this Act section nineteen, sub-section three, of the Sanitary Act, 1866, shall be read and construed as though the words "not being the chimney of a private dwelling house" had been omitted therefrom, and the said words shall be and the same are hereby repealed.

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